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**Finance or Demand: What drives the Responses of Young
and Small Firms to Financial Crises?**

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Abstract

Using a large dataset of Greek firms over the period 1998-2014, we investigate the excess sensitivity of small and young firms to the Greek financial crisis, along with the potential sources and aggregate implications. Controlling for size effects, the decline in sales growth rate during the crisis was about 6.6 percentage points larger in young firms than in their mature counterparts. Controlling for age effects, the decline in sales growth rate during the crisis was about 9.8 percentage points larger in small firms than in their large counterparts. Although the excess decline in small firms' growth rates is driven by both credit constraints and unexpected demand shocks, the excess decline in young firms is driven by financing constraints but not by unexpected demand shocks. The excess sensitivity of small firms accounts for about 13% of the drop in total output of the Greek economy during the crisis, with credit constraints and firm-level unexpected demand shocks contributing almost equally to this. The excess sensitivity of young firms accounts for about 14% of the aggregate output drop, with more than the half of this effect stemming from financing constraints.

Keywords: Firm growth, Greek Depression, firm age, firm size, financial frictions, demand shocks

JEL Classification: E23, E32, E44, G01, G30

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1 Introduction

An important topic of the literature on firm dynamics and macroeconomics is the differential responses of firms to aggregate shocks depending on their size and age. The studies focusing on firm size have considered sales, employment, inventories, and short-term debt and provided conflicting results.¹ The studies analyzing the responses of firms to aggregate fluctuations by firm age have demonstrated excess sensitivity of young firms but have only considered firm employment and not sales.² In this paper, we provide new evidence in the context of the Greek economy during a severe economic contraction (2010-2014), referred to as the Greek depression. We address three questions. First, are financial crises particularly disruptive to small (versus large) and to young (versus mature) firms' sales growth and if so, to what extent? Second, what are the driving forces of excess sensitivity of small or young firms: Credit or Demand conditions or maybe both? Third, what is the impact of excess sensitivity by age or size on the aggregate economy as it undergoes a severe financial crisis?

We use the largest available firm-level dataset for Greece over the period 1998–2014, and we establish excess sensitivity of young and of small firms' sales growth rates to the severe shock of the financial crisis. Controlling for size effects, we find that the decline in sales growth rate of Greek firms during the crisis was about 6.6 percentage points larger in young firms than in their mature counterparts. Controlling for age effects, we find the decline in sales growth rate of Greek firms during the crisis was about 9.8 percentage points larger in small firms than in their large counterparts.

Then, we examine the impact of credit supply disruption and of firm-level unexpected demand shocks on the documented sensitivity of young and of small firms. We find that credit constraints impacted disproportionately small firms' sales growth during the crisis reducing it by 5 percentage points at the margin compared to large firms, and young firms' sales growth rates by 7.8 percentage points compared to mature firms. This situation of high financial distress was accompanied by unfavorable changes in unexpected demand for Greek firms. We identify firm-level unexpected demand shocks (UDS hereafter) that affect the level of firm sales following the approach of [Kumar and Chang \(2019\)](#). First differences in UDS, then, relate to firm sales growth. Greek firms faced on average ten times lower UDS during the Greek Depression relative to the pre-crisis period. Declines in UDS explain part of the excess sensitivity of small firms but not of young firms. Specifically, the excess decline in small (versus large) firms' sales growth rates during the crisis was 8.4 percentage points larger in observations with year-on-year declines in UDS.

¹While some researchers document that small firms' sales are more sensitive than those of large firms to monetary shocks ([Gertler and Gilchrist, 1994](#)) and to the business cycle ([Crouzet and Mehrotra, 2021](#)), others assert that small and large firms' sales (along with inventories and short-term debt) are equally responsive to recessions ([Chari et al., 2013](#); [Kudlyak and Sanchez, 2017](#)). Moreover, although there is important evidence that small employers are more responsive than large to recessions ([Sharpe, 1994](#); [Fort et al., 2013](#); [Siemer, 2019](#); [Mehrotra and Sergeyev, 2021](#)), other studies provide evidence for the opposite ([Moscarini and Postel-Vinay, 2012](#); [Mian and Sufi, 2014](#)).

²[Fort et al. \(2014\)](#), [Siemer \(2019\)](#), and [Mehrotra and Sergeyev \(2021\)](#) find that young firms' employment growth is more sensitive to recessions than that of mature firms.

Our results have important aggregate implications. The total (gross) output of the Greek economy dropped by 23% during the financial crisis from 2009 to 2014. Following the methodology of [Chodorow-Reich \(2014\)](#), we show that a significant part of this reduction, namely 26.7%, stems from the excess decline in young (13.7%) and in small (13%) firms’ growth rates. Regarding this part of the drop in Greek output, i.e. 26.7% of the total drop, 38% is explained by financing constraints and 10.5% by UDS. Specifically, financing constraints explain 54.3% of the excess sensitivity of young firms, while 42.3% of the excess sensitivity of small firms is explained by financing constraints and UDS (in roughly equal parts).

There is an extensive theoretical and empirical literature indicating financing constraints (FCs hereafter) as a source of the over-responsiveness of small (relative to large) and of young (relative to mature) firms to aggregate shocks ([Cooley and Quadrini, 2006](#); [Khan and Thomas, 2013](#); [Chodorow-Reich, 2014](#); [Buera et al., 2015](#); [Duygan-Bump et al., 2015](#); [Siemer, 2019](#); [Mehrotra and Sergeyev, 2021](#)). This idea is motivated by the “financial accelerator” theory of [Gertler and Gilchrist \(1994\)](#), asserting that financial frictions can amplify the response of the economy to aggregate shocks, and from the fact that credit constraints are closely connected with the size and the age of a firm.³ In Greece, banks are the only source of funding for the vast majority of enterprises. The near-collapse of the entire banking system during the Greek financial crisis translated into an aggregate credit supply shock, common to all banks and firms in the economy (see [Fakos et al., 2022](#)). Thus, we can use firm- (or industry-) specific characteristics to identify which firms were more likely to be affected by this aggregate credit-supply shock. Following the work of [Giroud and Mueller \(2016\)](#) and [Fakos et al. \(2022\)](#), we identify more credit-constrained firms by using firm financial leverage in 2008, the last year before the onset of the crisis. As an alternative measure, at the industry level, we utilize the [Rajan and Zingales’ \(1998\)](#), measure of external financial dependence.

Turning to the role of demand, firms face in practice a substantial amount of transitory demand shocks, that may have an impact on firm sales growth. There is important empirical evidence that idiosyncratic demand shocks play a predominant role in the growth and variability of firm sales ([Hottman et al., 2016](#); [Argente et al., 2018](#); [Eslava and Haltiwanger, 2020](#)). During the crisis, the Greek economy was confronted with a deep demand contraction that was amplified by austerity measures. Moreover, a large part of the decline in the gross output of the Greek economy during the Depression stemmed from firm-specific shocks ([Giannoulakis and Sakellaris, 2021a](#)). For this reason, we treat this “demand contraction” as a series of less favourable firm-specific unexpected demand shocks, identified using inventory data and the approach of [Kumar and Chang \(2019\)](#).

Greece is an interesting laboratory for studying the differential responses of firms to a large aggregate shock, associated with a financial crisis, either from the side of demand or of credit supply. First, the Greek Depression is one of the largest economic crises an advanced economy

³[Gertler and Gilchrist \(1994\)](#) argued that size serves as a proxy for the degree of financing constraints while other authors have argued that age is the relevant proxy for financially constrained firms (see for example: [Cloyne et al. 2019](#); and [Dinlersoz et al., 2018](#)).

has ever faced: its magnitude and length have no precedent among other countries and previous economic recessions (see Figure 1).⁴ Second, Greek firms faced unprecedented financial distress during the Greek Depression: the banking system had to be bailed out to prevent its collapse, while corporate bond issuance dropped to nearly zero. Third, the crisis was preceded by a period of economic euphoria and rapid leveraging rendering many Greek firms more vulnerable to the financial crisis that followed. These facts make Greece an interesting case for examining

***** Insert Figure 1 here *****

Our empirical approach consists of four steps. First, building on [Siemer \(2019\)](#), we model firm growth by utilizing econometric specifications with interaction terms between categorical variables for firm age and size and a financial crisis indicator. These specifications enable us to capture the differentials in firm growth patterns by firm size and age before and during the Greek Depression. An important advantage of our approach is that we capture the age-size dependence (see [Haltiwanger et al. \(2013\)](#) for more details) by augmenting the growth model with age-size interaction terms. This element of our analysis is very important since it allows us to evaluate the crisis effect on young (small) relative to mature (large) firms controlling for size (age) effects.⁵

Second, we correct for econometric bias due to endogenous selection and sampling. Firm entry and exit lead to endogenous selection into our dataset. The fact that our dataset is not a census may create sampling bias: smaller firms are less likely to be included. These two potential sources of bias are inherent in most datasets used in the literature of growth dynamic and macroeconomics but the consequences are mostly ignored in practice.⁶ We deal with this double bias by employing a method due to [Olley and Pakes \(1996\)](#). In particular, we augment the sales growth model of the first step with [Olley and Pakes 's \(1996\)](#) correction term for selection and sampling bias.

Next, following the work of [Duygan-Bump et al. \(2015\)](#), we quantify the differential effect of the crisis on young relative to mature (controlling for size) and on small relative to large (controlling for age) Greek enterprises. Having sufficient evidence for the excess sensitivity of young (relative to mature) and of small (relative to large) firms to the Greek Depression, we then investigate the role of credit constraints and unexpected demand shocks in this documented sensitivity. We identify FCs and UDS as mentioned above and we investigate the role of each factor, controlling each time for the effects of the other.

Finally, following the methodology of [Chodorow-Reich \(2014\)](#) and [Siemer \(2019\)](#) and assuming a partial equilibrium, we construct counterfactual paths for aggregate sales growth under the alternative assumption that the responses of Greek firms to the financial crisis are the same across

⁴The crisis erupted in 2010. Four years later, the Greek economy had lost 22% of its gross output. See [Gourinchas, et al. \(2017\)](#), [Chodorow-Reich et al. \(2019\)](#), [Ioannides and Pissarides \(2015\)](#) and [Fakos et al. \(2022\)](#) for more details.

⁵Results for firm size might be driven by age if that is not controlled for. For instance, [Haltiwanger et al. \(2013\)](#) showed that when they control for age effects there is no systematic relationship between firm growth and size in the US economy. Moreover, [Siemer \(2019\)](#) demonstrated that the effect of financial constraints on small firms during the Great Recession in the US was driven to a large extent by young firms.

⁶The recognition of the problem is not new (see for instance the work of [Mansfield, 1962](#); [Hall, 1987](#); and [Marsili, 2001](#)).

the firm age and size distributions and compare these counterfactuals against realized aggregate sales growth. Additionally, we quantify the aggregate implications of more intense FCs, and of less favorable UDS.

Our evidence comes from proprietary firm-level data obtained from ICAP Group, S.A., a private research company that collects detailed balance sheet and income statement information for S.A. and Limited-liabilities companies in Greece. These companies are legally required to publish their accounts annually and ICAP strives to cover the universe of Greek firms.⁷ Our dataset contains firm-level information for approximately 80,500 Greek firms operating in all sectors, except for banks and insurance companies, for the time period 1998 - 2014. It is the largest available dataset for the Greek economy. The coverage in our sample is consistently high: the dataset covers roughly 60 percent of the gross output reported in the OECD for the Greek economy. An important aspect of the dataset is that it includes start-ups, as well as information on firm age. This study examines the growth of firms of all age and sales cohorts at both the intensive (continuing firm) and extensive (entrant and exiter) margins.

The remainder of the paper is structured as follows. Section 2 discusses how our findings contribute to the literature and what are the policy implications. Section 3 details the data and the variables utilized in this study, provides some descriptive statistics, and reviews stylized facts on the growth patterns of Greek firms by age and size before and during Greek Depression focusing on the role of FCs and UDS in these patterns. Section 4 presents the empirical methodology we follow. Section 5 includes the baseline estimation results, while Section 6 presents a sensitivity analysis of these results. Section 7 analyzes the aggregate implications of the excess sensitivity of young and small firms. Finally, Section 8 concludes.

2 Contribution to the Literature

This paper provides evidence for two propositions: (1) financial crises are more disruptive to young (relative to mature) and to small (relative to large) firms; and (2) the excess sensitivity of small firms to financial crises is explained to a large extent by both credit constraints and unexpected demand shocks, while that of young firms by credit constraints but not by demand shocks. These propositions are tested in the context of the Greek Depression (2010-2014).

Our study contributes to the large literature on the differential responses of firms to aggregate shocks by size and age in two ways. First, our findings revisit the above literature focusing not on business cycle downturns (as the previous literature has done) but to a uniquely severe and unprecedentedly prolonged financial crisis, the Greek Depression. Second, it is the first study that explores the differential responses of firms to an aggregate shock by age (and size) focusing on sales dynamics rather than employment.⁸

⁷ICAP provides data for more than the 90% of such firms.

⁸This is a very important element of our analysis since firm growth dynamics across the age and the size distributions depend to a large extent on whether the growth and size indicators are defined in terms of sales or

Our paper also contributes to the literature on the sources of the differential sensitivity of firms to aggregate shocks by size and age. The dominant idea in this literature is that the greater sensitivity of small and of young firms to aggregate shocks stems from credit constraints. In their seminal contributions, [Bernanke and Gertler \(1989\)](#) and [Bernanke et al. \(1999\)](#) showed how aggregate shocks can be amplified by procyclical movements in credit supply. A large class of theoretical models was developed based on the joint prediction that firm size is correlated with the severity of financial frictions and that more constrained firms are more cyclically sensitive (some examples are those of [Cooley and Quadrini, 2006](#); [Khan and Thomas, 2013](#); [Buera et al., 2015](#); and [Mehrotra and Sergeyev, 2021](#)). Moreover, the work of [Chaney et al. \(2012\)](#), [Duygan-Bump et al. \(2015\)](#) and [Siemer \(2019\)](#) are some empirical examples of how the differential responses of firms to aggregate shocks across the firm size distribution relate to a “financial amplification channel”. On the contrary, the recent work of [Crouzet and Mehrotra \(2021\)](#) documents that the differential responses of firms to the business cycle by size are not driven by financial frictions. Our findings support the view of a “financial amplification mechanism” and are in contrast with those of [Crouzet and Mehrotra \(2021\)](#).

Moreover, another strand of this literature has focused on the role of young or small firms in the reduction of aggregate employment in response to credit contractions, especially during the Great Financial Crisis. For instance, [Mian and Sufi \(2014\)](#) and [Chodorow-Reich \(2014\)](#), use the absence or presence of differences by firm size to test the existence of a financial amplification channel in the USA during the Great Recession. In the same spirit, in this study we explore the role of young or small firms in the reduction of the gross output of Greek economy, in response to a credit supply shock, during the Greek Depression. We show that the excess sensitivity of small and especially of young firms is responsible for a large part (26.7%) of the persistent decline in the gross output of the Greek economy during the crisis with about 38% of this part stemming from FCs.

Finally, our paper provides an important extension to the above literature by introducing a role for firm-level unexpected demand shocks, beyond the role of credit. [Kee and Krishna \(2008\)](#) provide some interesting theoretical arguments about the connection of demand shocks with firm age and size, and we described in the introduction empirical evidence linking idiosyncratic demand shocks and firm size and dynamics. Our contribution is to show that an important part of the excess sensitivity of small (but not of young) firms to the Greek financial crisis arises from less favourable firm-level UDS. Moreover, we demonstrate that UDS have important aggregate implications.

Our results are important for future theoretical work. There is a large class of theoretical models and empirical applications that attribute the excess sensitivity of small firms to the credit constraints that these firms face (see for example [Cooley and Quadrini, 2006](#); [Khan and Thomas, 2013](#); [Buera et al., 2015](#); [Chodorow-Reich, 2014](#); [Duygan-Bump et al., 2015](#); [Gilchrist et al., 2018](#); [Siemer, 2019](#); and [Mehrotra and Sergeyev, 2021](#)). Although our findings support the importance of employment ([Giannoulakis and Sakellaris, 2021b](#)).

of credit constraints in the greater sensitivity of small (relative to large) firms to financial crises, they also underline the role of idiosyncratic demand shocks. We find that credit constraints and idiosyncratic transitory demand shocks contribute almost equally to the documented excess sensitivity of small firms. Our findings indicate that for a deeper insight, there is a need for theoretical models that incorporate idiosyncratic demand shocks as a mechanism of the greater sensitivity of small relative to large firms.

Second, there is an important and growing literature on the link between firm life-cycle dynamics and aggregate fluctuations. A recent impetus has come from [Haltiwanger et al. \(2013\)](#) who demonstrate the important role of business startups and young businesses in U.S. job creation. Their findings highlight the need for theoretical models and empirical analyses that focus on the start-up process - both the entry process and the subsequent post-entry dynamics. [Clementi and Palazzo \(2016\)](#) develop a model where the pro-cyclicality of entry and the positive association between age and firm growth deliver amplification and propagation of aggregate shocks in a competitive framework. [Sedlacek \(2019\)](#) emphasizes the role of young firms in shaping the recovery from economic recessions. He finds that young firms account for 40% of aggregate employment fluctuations in the U.S. (even though they employ only 16% of all workers). [Sedlacek Sterk \(2017\)](#) show that employment fluctuations of startups are procyclical and persistent, and cohort-level employment variations are largely driven by differences in firm size, rather than the number of firms. They emphasize that, during downturns, startups are of a different type that is less likely to grow. A related paper is [Pugsley and Sahin \(2019\)](#) who analyze the effect of the secular decline in the share of startups on the aggregate economy. They find that the employment growth rates state of young firms are more cyclical than those of mature firms. A common feature of the theoretical frameworks in the above papers is that finance does not matter. Our empirical results suggest that it is important to introduce financing constraints on young firms in such equilibrium models. This is likely to increase the level of amplification and propagation of shocks. Young firms do not have strong banking relationships or access to capital markets. Thus, they are more likely to be exposed to financial dislocation especially during financial crises.⁹

3 Data and Variables

3.1 Data Description

We employ a proprietary firm-level dataset obtained from ICAP Group, S.A., a private research company that collects and maintains detailed accounting information for S.A. (“Société Anonyme” and Limited-Liability (Ltd) companies in Greece. These firms are required by law to publish accounts annually and ICAP strives to include all publicly available company accounts without

⁹An interesting example in this direction is that of [Hochmuth \(2021\)](#). The author extends the financial accelerator model of [Bernanke and Gertler \(1989\)](#) and [Bernanke et al. \(1999\)](#) with endogenous firm entry and a detailed firm age structure. In her model, young firms are more financially constrained than old. Thus, a credit shock is more destructive for young enterprises leading to a larger decline of aggregate employment.

any further selection criterion. The coverage for this subset of the universe ranges between 90% and 96% for the years 2011- 2014 (see Table A1 in Appendix A). All companies in the dataset are employers, while roughly 99.5% of them are private.¹⁰ ICAP data is used by commercial banks for credit decisions and by the central bank for credit rating information. Thus, the data are carefully controlled.

Our dataset contains annual firm-level information for approximately 80,500 Greek firms operating in all sectors, except for banks and insurance companies, for the time period 1998 - 2014.¹¹ It has financial accounting information from detailed balance sheets and income statements, along with detailed information for establishment date, two-digit NACE Rev. 2 industry classification (decomposing the economy into 97 industrial sectors of economic activity.), and location in one of the 52 prefecture administrative units. The time period of our dataset allows us to examine the differential responses of firms by age and size to an unprecedented severe financial crisis, the Greek Depression (2010-2014). Details on the cleaning procedures for the firm-level data can be found in Appendix A.

To the best of our knowledge, this paper uses the largest available firm-level dataset for the Greek economy. The coverage in our sample is consistently high: it averages roughly 60 percent for the aggregate economy (see Table A2 in Appendix A).¹² Moreover, it is reassuring that the time series properties of the aggregated magnitude for gross output from our raw sample track aggregate data quite well. As Figure A1 in Appendix A illustrates, the trajectory of total firm sales in our sample track closely the trajectory of gross output at the macro-level.

Figure 2 presents the dynamic patterns of average annual firm sales growth rates of Greek firms for the time period 1999-2014. In order to investigate whether the growth rates of the firm-level data resemble the growth path of the Greek economy, we also include the growth rates of Gross Domestic Product (GDP) annual time series, as reported in the OECD Database. Moreover, a matter of high importance in the analysis of firm growth dynamics, highlighted very early in the literature by Mansfield (1962), is the “selection effect or bias” that the firm entry-exit process creates. In order to investigate the role of selection bias on firm growth, we present the patterns of both unconditional (solid lines) and conditional (dashed lines) firm growth rates, with the latter applying to firms that survived until 2014 (i.e. the last available year in our sample).

We can discern two phases of the economic cycle: the “boom” (1998-2009) and the “depression” (2010-2014). The course of conditional firm growth is quite similar to that of GDP. The 2008 global financial crisis led to a dramatic fall of both firm and aggregate growth and economic

¹⁰To the best of our knowledge, none of the widely used databases with firm-level data - either the Orbis-Amadeus for Europe or the Census Bureau’s Longitudinal Business Database (LBD) for the USA - contain information for non-employers and ICAP is not an exception in this rule. See Haltiwanger et al. (2013) and Kalemni-Ozcan et al. (2015) for more details on the issue.

¹¹We start our analysis with a sample of 100,657 firms. After some cleaning, we have a final dataset containing information for 80,597 firms. Our panel dataset is unbalanced. See Appendix A for more details.

¹²The coverage in our sample is better than that in the Orbis-Amadeus database, the only alternative data source for the Greek economy. Kalemni-Ozcan et al. (2015) provide a meticulous presentation of the Orbis-Amadeus database for many countries, including Greece. In Table 1 (p. 7) of their study, we can see that the coverage of the aggregate economy, based on gross output, in Orbis-Amadeus is 52% for Greece over the period 1999-2012.

activity deteriorated further with the eruption of the Greek financial crisis. In 2014, an anaemic recovery can be observed in both GDP and firm growth rates. Even though the trajectory of the conditional firm growth is very close to that of GDP, the unconditional firm growth has a more divergent and unstable path, a fact that underlines the importance of sample selection in the analysis of firm dynamics. The econometric methodology we follow in this study enables us to correct for selection bias due to both business starts and failures and the sampling procedure. This methodology will be presented in the Section 4.

***** Insert Figure 2 here *****

3.2 Variables and Measurement

3.2.1 Firm Growth, Age and Size

We define firm size as the logarithm of gross sales in period $t-1$, deflated by the Producer Price Index (PPI).¹³ Following Fort et al. (2013), we separate firms into three broad size groups based on the percentiles of the firm size distribution. We consider firms as “small” for percentiles 1-50, “medium” for percentiles 51-90 and “large” for the percentiles 91-100.¹⁴

Regarding firm age, this is defined as the difference between the current year of operation and the year of establishment for each firm. For start-up firms, age is set equal to one. An important advantage of our dataset is that ICAP’s information for the year of establishment comes from administrative records. Following Fort et al. (2013), we separate firms into two age groups: firms are “young” if they are less than 6 years old and “mature” if they are 6 years old or older. Twenty three (23) percent of firms in our sample are young.

There are different formulas for measuring growth rates. A traditional approach is to define the annual firm growth rate, $g_{i,t}$, as the logarithmic difference $\Delta \ln S_{i,t}$ where $S_{i,t}$ denotes the size of firm i at period t (i.e. the gross sales of firm i at period t , deflated by the relevant Producer Price Index). However, an important drawback of log differences as a measure of relative change is that it is not defined for exiting and entering firms with $S_{i,t} = 0$ and $S_{i,t-1} = 0$, respectively.

For this reason, in this study we employ as a measure for firm growth the Davis et al.’s (1996) bounded growth rates (DHS hereafter):

$$g_{i,t} = \frac{(S_{i,t} - S_{i,t-1})}{0.5(S_{i,t} + S_{i,t-1})} \quad (3.1)$$

The DHS measure for firm growth is a second-order approximation of the log difference for growth rates around 0. The DHS growth rate like the log first difference is a symmetric growth rate measure but has the added advantage that it accommodates entry and exit allowing us to

¹³The data for the Producer Price Index (PPI) have been collected from Eurostat (Structural Business Statistics).

¹⁴Under this size classification a firm can be considered as “small” if its annual gross sales are less than €750,000, “medium” if its sales are more than €750,000 and less than €6,500,000, and “large” if its gross sales are more than €6,500,000.

examine the role of the extensive margin of firms in our analysis. Also, the DHS growth rate is not only symmetric but bounded between -2 (exit) and 2 (entrant).

However, to ensure the robustness of our results we repeat our analysis utilizing the log differences measure for firm growth as described above. See Section 6.1 for more details.

3.2.2 Measuring Firm Financing Constraints

Domestic banks are the overwhelmingly predominant source of external financing for Greek firms. During the Greek Depression, the economy was confronted with a severe banking crisis: the entire banking system almost collapsed requiring bailout through a series of recapitalizations. Thus, the banking crisis can be best described as an aggregate shock to credit supply, affecting all firms in the economy regardless of which bank they used. [Fakos et al. \(2022\)](#) provide evidence that during the Greek Depression the contraction in credit supply was widespread and had a common component. This makes it very difficult to identify firm-specific effects of credit supply using matched bank-firm data and renders the [Amiti and Weinstein \(2013\)](#) methodology inapplicable to the case of the Greek Depression. In this paper, in order to identify which firms were more affected by this aggregate credit-supply shock we use firm- or industry-specific characteristics.

We use two alternative measures for financing constraints, one at the firm-level and one at the industry-level. In particular, following [Giroud and Mueller \(2016\)](#) and [Fakos et al. \(2022\)](#) we use financial leverage (measured by the debt-to-assets ratio) at the firm-level as a proxy for credit constraints. Figure 3 presents the evolution of average financial leverage over the period 1998-2014. The Greek Depression was preceded by a period of rapid leveraging. The eruption of the global financial crisis in 2008 and the Greek sovereign crisis that followed led to considerable deleveraging indicating tighter credit supply. The patterns presented in Figure 3 are consistent with a story in which firms accumulated debt to grow prior to the crisis, and the banking crisis that culminated in 2012, tightened credit supply, leading highly leveraged firms to hit borrowing constraints.

To this end, we separate firms into two categories: firms entering the crisis with high leverage (considered to be financially constrained) and firms entering the crisis with low leverage (considered not to be financially constrained). Since 2007 is the last year of the pre-crisis era in which leverage was still increasing (according to Figure 3), we include in the first category all firms with 2007 leverage above the median of the distribution for the year 2007. The rest are classified in the second group. We assume that all firms were not financially constrained during the pre-crisis period. For our analysis, we create a dummy variable “FC” which receives the value 1 for a firm belonging in the first category and 0 otherwise.

***** Insert Figure 3 here *****

As an alternative proxy for financing constraints, we construct an industry-level measure for external financial dependence, which was originally proposed by [Rajan and Zingales \(1998\)](#). We

follow the procedures described in [Cetorelli and Strahan \(2006\)](#). In particular, we define external financial dependence (EFD hereafter) as the proportion of capital expenditures financed with external funds, i.e.:

$$EFD_{j,t} = \frac{\sum_t CapEx_{j,i,t} - \sum_t CF_{j,i,t}}{\sum_t CapEx_{j,i,t}} \quad (3.2)$$

where $CapEx_{j,i,t}$ and $CF_{j,i,t}$ denote the “capital expenditures” and “operating cash flows” of firm “i” in sector “j” and year “t”, respectively. A value of EFD smaller than zero indicates that a firm has more cash flow than capital expenditures and thus tends to have internal funds available. A value greater than zero indicates that a firm might be financially constrained as capital expenditures exceed available cash flow and therefore the firm needs to raise additional funds to finance its investment.

Capital expenditures is defined as follows:

$$CapEx_{i,t} = \Delta(FTA)_{i,t} + Depr_{i,t} \quad (3.3)$$

where $\Delta(FTA)_{i,t}$ denotes the net change in fixed tangible assets and $Depr_{i,t}$ stands for the depreciation expense listed in the income statement. Moreover, (operating) cash flows, net of changes in inventories, account receivable and accounts payable, are defined as follows:

$$CF_{i,t} = NI_{i,t} + DA_{i,t} + \Delta WC_{i,t} \quad (3.4)$$

where $NI_{i,t}$ and $DA_{i,t}$ denote the net income and depreciation & amortization respectively, while $\Delta WC_{i,t}$ denotes the change in working capital (i.e. the difference between current assets and current liabilities) of firm “i” in year “t”.

After constructing the EFD ratio for each firm, we use the median value for all firms in each 2-digit NACE2 category as our measure of external finance needs for that industry. Finally, we separate all sectors in the economy into composite sectors of high - and low - EFD, which are defined as those above and below the median external financial dependence measure (over all sectors), respectively. For our analysis, we create a dummy variable “high-EFD” which receives the value 1 if a sector is highly dependent on external finance (financially constrained) and 0 otherwise.

3.2.3 Measuring Firm-level Unexpected Demand Shocks

During the Greek Depression, the economy was confronted with a deep and persistent contraction in demand that was dramatically amplified by the reform programs adopted by Greece in exchange for funding from its European and international lenders ([Ioannides and Pissarides, 2015](#)). [Giannoulakis and Sakellaris \(2021a\)](#) showed that a large part of the Greek Depression can be attributed to firm-specific shocks. This points to the importance of measuring this “demand contraction” as a series of less favourable firm-specific unexpected demand shocks.

Since neither product prices nor quantities are available in our dataset, we cannot identify firm-level demand shocks in a traditional manner. Instead, we adopt a novel identification strategy based on the recent work of [Kumar and Zhang \(2019\)](#). These authors proposed a method to identify unexpected demand shocks at the firm level, using the inventories of finished goods and work-in-progress. The main idea behind this approach is that the within-firm deviation of inventory stock over time from the targeted level of inventory each period contains important information about (unexpected) demand shocks.

Following [Kumar and Zhang \(2019\)](#), we can identify a short-term unexpected demand shock at the firm-level through the following equation:

$$\log\left(\frac{Q_{i,t}^S}{Q_{i,t} + Inv_{i,t}^b}\right) = -\log(1 + \lambda_i) + \zeta_{i,t} \quad (3.5)$$

where $Q_{i,t}^S$ is the quantity sold by firm i at period t , $Q_{i,t}$ is the output of firm i at period t , $Inv_{i,t}^b$ are the inventories of finished goods and work-in-progress of firm i at the beginning of the period t , λ_i the inventory share of firm i , and $\zeta_{i,t}$ is a transitory demand shock.

Using the fact that output is measured as quantity sold plus changes in inventories, i.e. $Q_{i,t} = Q_{i,t}^S + \Delta Inv_{i,t}$, and under the assumption that the beginning-of-year inventory has the same price as the quantity sold in that period, the above equation is equivalent to:

$$\log\left(\frac{S_{i,t}}{S_{i,t} + VInv_{i,t}}\right) = -\log(1 + \lambda_i) + \zeta_{i,t} \quad (3.6)$$

where $S_{i,t}$ denotes the gross sales of firm i at period t , and $VInv_{i,t}$ the value of end-of-period inventories of finished goods and work-in-progress of firm i at period t .

How do these short-term unexpected demand shocks affect firm sales growth rates? By first differencing equation (3.6) and after some rearrangement, we get the following expression:

$$\Delta \ln S_{i,t} = \Delta \ln \underbrace{(R_{i,t}^Q + VInv_{i,t}^b)}_{S_{i,t} + VInv_{i,t}} + \Delta \zeta_{i,t} \quad (3.7)$$

where $R_{i,t}^Q$ is the value of production $Q_{i,t}$, $VInv_{i,t}^b$ is the value of the beginning-of-period inventories, and $\Delta \ln S_{i,t}$ is the sales growth rate of firm i at period t .

The above formula can be interpreted as follows. The firm growth rate of sales is equal to the growth rate of the value of quantity supplied (value of production plus the value of the beginning-of-period inventories) plus the change in unexpected demand shocks. Therefore, firm growth depends directly on changes in (unexpected) demand shocks. In this paper, we will examine whether the excess sensitivity of young or small firms to the Greek crisis was due in part to exposure to lower (less favourable) demand shocks.

To answer this question we construct a measure of “less favourable demand shocks” instances at the firm level. The relevant measure for a firm i is chosen to be $\Delta \zeta_{i,t}$. We construct the

firm-specific series for $\Delta\zeta_{i,t}$ utilizing two alternative approaches.

The first approach, that will be our baseline approach, is based on [Kumar and Zhang’s \(2019\)](#) methodology. We recover the unexpected demand shocks $\zeta_{i,t}$ by estimating equation (3.7). We model firms’ optimal inventory share, $-\log(1 + \lambda_i)$, as a firm-specific fixed effect. This leaves the firm-level inventory share completely flexible and guided by data only. The transitory demand shock is the residual from the estimation of equation (3.7), $\hat{\zeta}_{i,t}$. Following [Kumar and Zhang \(2019\)](#), we replace the estimated demand shock by the conditional lower bound (i.e. $\log(1 + \hat{\lambda}_i)$) when inventory is zero. We define the changes in the unexpected demand shocks as the first difference of the $\hat{\zeta}_{i,t}$.

The above approach has an important limitation: it requires a long panel data set in order to estimate the firm effect with credibility. Our panel has 17 periods, which is arguably long enough to estimate equation (3.7) with firm dummies. However, the panel is unbalanced, with a much shorter tenure on average for each firm.

To ensure the robustness of our results, we utilize an alternative measurement approach. We directly identify the changes (first differences) in unexpected demand shocks through equation (3.7). The limitation of this approach is that changes in demand shocks will be zero for firms with zero inventories. In Section 6.3, we present the results based on this alternative measure.

For our analysis, we create a dummy variable LUD (denoting lower - or less favourable - unexpected demand shocks), which receives the value 1 if a firm faced a lower unexpected demand shock in period t compared to period $t - 1$ (i.e. $\Delta\hat{\zeta}_{i,t} < 0$) and 0 otherwise. According to our measure, Greek firms faced on average ten times lower unexpected demand shocks during the Greek Depression (relative to the pre-crisis period). This lends support to the hypothesis that an important part of the economic slowdown during the crisis is due to firm-level unexpected demand shocks (see Table 1).

3.3 Basic Descriptive Statistics and Stylized Facts

Table 1 reports some descriptive statistics of the variables described above. To examine the impact of the Greek financial crisis on our basic variables, we present the summary statistics separately for the pre-crisis (1998-2009) and the crisis (2010-2014) periods.

***** Insert Table 1 here *****

Several observations emerge. The pre-crisis period was an era of euphoric growth (the average firm sales growth rate was roughly 17.4%) and intensive leveraging for Greek firms. The Greek Depression that followed was particularly destructive for Greek firms. Average firm growth declined more than 171% relative to its pre-crisis level and became 43% more volatile. Average firm sales declined reflecting the decline in aggregate output (23% from 2009 to 2014). The somewhat higher average age of Greek firms during the crisis can be attributed to the decline in the firm entry rate during the Greek Depression. An important deleveraging episode took place during the

crisis, as Figure 3 indicates. The over-accumulation of debt by Greek firms during the pre-crisis period likely brought them closer to their borrowing constraints rendering them more vulnerable to the financial crisis that followed. This situation of high financial distress was accompanied by unfavorable changes in unexpected demand for Greek firms. Greek firms faced on average ten times lower UDS during the Greek Depression relative to the pre-crisis period.

In Appendix B, we review some facts on the evolution of firm sales growth in Greece during the period 1998-2014, focusing on the distinction by firm age and size along with the role of financing constraints and unexpected demand shocks. We briefly summarize these facts here:

1. Sales growth rates were significantly higher for young (small) firms than for their mature (large) counterparts (Figure B1).
2. The Greek Depression was more disruptive (in terms of sales growth reductions) to young (small) firms than to their mature (large) counterparts (Table B1).
3. Highly financially constrained firms were hit more by the Greek financial crisis than their counterparts with looser constraints across all age and size groups. This result was much stronger for young (relative to mature) and for small (relative to large) firms (Figure B2).
4. The Greek Depression was more disruptive to firms that experienced less favourable demand shocks across all age and size groups. Although this result was particularly strong for small (relative to large) firms, it was mild for young (relative to mature) firms (Figure B3).

The above analysis shows that the Greek Depression was particularly destructive for young and small firms. Financing constraints and unexpected demand shocks may have played an important role in this excess sensitivity of young and small firms to the financial crisis. The role of unexpected demand shocks is much more important for small firms than for young. In the next section, we examine these facts within an empirical model that controls for differences in size, age, and other firm characteristics.

4 Empirical Specification and Identification

Using the Greek Depression as an economic laboratory, the first objective of this study is to examine the differential responses of firms to this financial crisis by age and size. To this end, we formulate the following testable hypothesis:

Hypothesis H1:

- (a) The Greek Financial Crisis was more disruptive to young than to mature firms.
- (b) The Greek Financial Crisis was more disruptive to small than to large firms.

To test this hypothesis, we employ the following econometric specification:

$$g_{i,t} = \beta_0 + f(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, \text{crisis}_t; \beta) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + \xi_{i,t} \quad (4.1)$$

where $g_{i,t}$ denotes the growth rate of firm i at period t , $\text{young}_{i,t}$, $\text{small}_{i,t}$ and $\text{large}_{i,t}$ are indicator variables defined in Section 3.2, and crisis_t is a dummy variable that receives the value 1 for the crisis period (2010 - 2014). The function $f(\cdot)$ is linear with complete interactions in its arguments. Specifically:

$$\begin{aligned} f(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, \text{crisis}_t; \beta) = & \beta_1 \text{young}_{i,t} + \beta_2 \text{small}_{i,t} + \beta_3 \text{large}_{i,t} \\ & + \beta_4 (\text{young} \times \text{small})_{i,t} + \beta_5 (\text{young} \times \text{large})_{i,t} \\ & + \beta_6 \text{crisis}_{i,t} + \beta_7 (\text{young} \times \text{crisis})_{i,t} + \beta_8 (\text{small} \times \text{crisis})_{i,t} \\ & + \beta_9 (\text{large} \times \text{crisis})_{i,t} + \beta_{10} (\text{young} \times \text{small} \times \text{crisis})_{i,t} \\ & + \beta_{11} (\text{young} \times \text{large} \times \text{crisis})_{i,t} \end{aligned}$$

This functional form allows us to evaluate the crisis effect on young (small) relative to mature (large) firms controlling for size (age) effects. This is a very important element of our analysis since results for firm size may be driven by age, and vice versa. For instance, [Haltiwanger et al. \(2013\)](#) showed that when controlling for age effects there is no systematic relationship between firm growth and size in the US economy. Moreover, [Siemer \(2019\)](#) demonstrated that the effect of financial constraints on small firms during the Great Recession in the US was driven to a large extent by young firms.

Since firm size and firm age distributions vary by industry as the growth rate patterns do as well ([Daunfeldt and Elert, 2013](#)), we control for detailed industry fixed effects (I_s). Additionally, we control for location fixed effects (L_c) by employing a set of prefecture dummies. These fixed effects allow us to capture (a part of) ex-ante firm heterogeneity.

Following the work of [Duygan-Bump et al. \(2015\)](#), after the proper estimation of econometric specification (4.1) (we will expand on this in the next pages), we can quantify the differential crisis effect on young (small) relative to mature (large) firms by computing the following double growth differentials:

$$\hat{\theta}_{age}^{Cr} = (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Cr} - (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Bm} \quad (4.1a)$$

$$\hat{\theta}_{size}^{Cr} = (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Cr} - (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Bm} \quad (4.1b)$$

The term $\hat{\theta}_j^T$ denotes the predicted mean growth rate (i.e. the marginal effects at the mean - MEM) of firms that belong in group $j \in \{\text{young, mature, small, large}\}$ during the period $T \in \{\text{pre-crisis, crisis}\}$ as estimated by model (4.1).¹⁵ Since model (4.1) consists of categorical variables and especially since these variables are interacted, the regression coefficients fail to capture correctly

¹⁵ $\hat{\theta}_{sml}$ and $\hat{\theta}_{lrg}$ are the differences relative to the omitted (medium) group.

the partial effect of the financial crisis on firms by age and size (Williams, 2012). For this reason, we utilize expressions (4.1a) and (4.1b) which are calculated based on the MEMs. More precisely, the differential impact of the crisis on young relative to mature firms is not $\hat{\beta}_7$, but rather (using 4.1a) it is $[\hat{\beta}_7 + \hat{\beta}_{10}\overline{small} + \hat{\beta}_{11}\overline{large}]$, where \overline{small} and \overline{large} correspond to the average portions of small and large firms in our sample. In other words, expression (4.1a) gives the differential impact of the crisis on young relative to mature firms properly adjusted to take into account the effects of the age-size dependence. In the same spirit, the differential impact of the crisis on small relative to large firms is not $[\hat{\beta}_8 - \hat{\beta}_9]$ but rather $[(\hat{\beta}_8 - \hat{\beta}_9) + (\hat{\beta}_{10} - \hat{\beta}_{11})\overline{young}]$ according to expression (4.1b) (where \overline{young} corresponds to the average portion of young firms in our sample). This is a key element of our analysis since this dependence has been ignored in previous empirical studies that try to quantify the differential impact of aggregate shocks on firms by age and size (see among others Chodorow-Reich, 2014; Duygan-Bump et al. (2015); Siemer, 2019; and Crouzet and Mehrotra, 2021).

Therefore, expressions (4.1a) and (4.1b) give us the impact of the Greek financial crisis on the growth rates of Greek firms with respect to their age (controlling for size) and size (controlling for age). A negative outcome implies that the fall of growth rate due to crisis was more severe in young (small) than mature (large) firms, verifying the testable hypothesis H1.

The second objective of this study is to explore whether differential sensitivities of young or small firms to the Greek financial crisis is driven by credit-supply or demand factors (or both). To explore this further, we formulate the following testable hypotheses:

Hypothesis H2:

- (a) The Greek Financial Crisis was more disruptive to young (relative to mature) firms that were highly financially constrained during the crisis.
- (b) The Greek Financial Crisis was more disruptive to small (relative to large) firms that were highly financially constrained during the crisis.

Hypothesis H3:

- (a) The Greek Financial Crisis was more disruptive to young (relative to mature) firms that were facing less favourable firm-level unexpected demand shocks.
- (b) The Greek Financial Crisis was more disruptive to small (relative to large) firms that were facing less favourable firm-level unexpected demand shocks.

To investigate the validity of hypotheses H2 and H3, we employ the following augmented version of econometric specification (4.1):

$$g_{i,t} = \alpha_0 + g(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, FC_{i,t}, LUD_{i,t}, \text{crisis}_t; \alpha) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + \varepsilon_{i,t} \quad (4.2)$$

where $FC_{i,t}$ is a dummy variable that separates firms into financially constrained and not financially constrained firms based on their financial leverage, and $LUD_{i,t}$ a dummy variable that indicates a firm that experienced a lower unexpected demand shock at period t than it did at period $t - 1$ (see Section 3.2 for the exact definitions of these variables). $g(\cdot)$ is a linear function of the variables $\text{young}_{i,t}$, $\text{small}_{i,t}$, $\text{large}_{i,t}$, $FC_{i,t}$, $LUD_{i,t}$, and crisis_t together with complete interactions among them. The exact form of function $g(\cdot)$ can be found in Appendix C. This functional form allows us to investigate the role of each factor (i.e. financing constraints or unexpected demand shocks), controlling each time for the effects of the other.

As before, we quantify the contribution of financing constraints and unexpected demand shocks in accounting for the differential crisis effect on young relative to mature and on small relative to large firms by computing the following triple-differences using the MEMs from (4.2):

$$\hat{\theta}_{age}^{Cr,F} = [(\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Cr} - (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Bm}]^1 - [(\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Cr} - (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Bm}]^0 \quad (4.2a)$$

$$\hat{\theta}_{size}^{Cr,F} = [(\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Cr} - (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Bm}]^1 - [(\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Cr} - (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Bm}]^0 \quad (4.2b)$$

The superscript “ F ” stands for the two factors that we are examining (i.e. $F \in \{\text{financing constraints, less favourable unexpected demand shocks}\}$). The superscript “1” and “0” correspond to the two groups of firms as classified by factor “ F ”. Specifically, for “financing constraints” 1 corresponds to financially constrained firms, while for “unexpected demand shocks” 1 to the group of firms that faced less favourable short-term unexpected demand shocks.

The above triple differences exploit variation in sales growth across three dimensions: time (before and during the crisis), firm age (young and mature) or size (small and large), and severity of financing constraints or incidence of unfavorable unexpected demand shocks. In other words, the third dimension helps us to isolate factors that may have a differential crisis impact on sales growth by firm age or size. An important advantage of our approach is that expressions (4.2a) and (4.2b) give the differential impact of the crisis on young (small) relative to mature (large) firms properly adjusted to take into account both the effects of the age-size dependence and the effects of differential exposure to credit constraints or unfavorable demand shocks.

A negative value for expressions (4.2a) and (4.2b) would imply that the differential effect of the Greek crisis on young (small) relative to mature (large) firms was larger in firms with tighter credit constraints (or with less favourable unexpected demand shocks), verifying the testable hypothesis H2 (or H3).

We now turn to our econometric strategy for correcting for potential sampling and selection bias. This is an important statistical concern. Bias may arise from endogenous firm selection

due to starting or closing a business, or from the sampling design and procedure of our dataset, which is not a census. The vital role of this problem in the analysis of firm dynamics has been pointed out early in the literature on firm growth (e.g. Mansfield, 1962; Evans, 1987; Hall, 1987). To address this issue we employ the methodology of Olley and Pakes (1996). Selection into the sample introduces a bias term in equations (4.1) and (4.2) as follows:

$$E[g_{i,t} | X_{i,t}^{(1)}, y_{i,t} = 1] = \beta_0 + f(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, \text{crisis}_t; \beta) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + E[\xi_{i,t} | X_{i,t}^{(1)}, y_{i,t} = 1] \quad (4.1')$$

$$E[g_{i,t} | X_{i,t}^{(2)}, y_{i,t} = 1] = \beta_0 + g(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, FC_{i,t}, LUD_{i,t}, \text{crisis}_t; \alpha) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + E[\varepsilon_{i,t} | X_{i,t}^{(2)}, y_{i,t} = 1] \quad (4.2')$$

where $X_{i,t}^{(1)}$ and $X_{i,t}^{(2)}$ denote the sets of explanatory variables of econometric specifications (4.1) and (4.2) respectively, and $y_{i,t}$ is an indicator function that takes the value 1 if firm i is active and included in our ICAP sample in period t and 0 otherwise.

The last terms in equations (4.1') and (4.2') are the *bias terms* due to endogenous selection and sampling. Following Olley and Pakes (1996), we consider these *bias terms* as function of the probability of being in the dataset at period t . Specifically, for specification (4.1'):

$$E[\xi_{i,t} | X_{i,t}^{(1)}, y_{i,t} = 1] \approx h^{(1)}(\hat{P}_{i,t}). \quad (4.3a)$$

and for specification (4.2'):

$$E[\varepsilon_{i,t} | X_{i,t}^{(2)}, y_{i,t} = 1] \approx h^{(2)}(\hat{P}_{i,t}). \quad (4.3b)$$

We use a first-order polynomial in $\hat{P}_{i,t}$ of functions $h^{(1)}(\cdot)$ and $h^{(2)}(\cdot)$. We obtain the probability of being in the dataset at period t by estimating the following binary choice model:

$$Pr(y_{i,t} = 1) = \Phi \left(\delta_0 + g(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, FC_{i,t}, LUD_{i,t}, \text{crisis}_t; \delta) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + \mu_{i,t} \right) \quad (4.4)$$

where $g(\cdot)$ stands for the same functional form we used in econometric specification (4.2). We assume normal disturbances, i.e. $\mu_{i,t} \sim N(0, \sigma_\mu^2)$.

The econometric specification (4.1') and its augmented version (4.2') are fully saturated dummy variable models. Following Haltiwanger et al. (2013), we estimate the econometric specifications (4.1') and (4.2') using OLS and correct standard errors for heteroskedasticity and autocorrelation. We augment the set of regressors with the predicted probability of a firm observation being included in the sample.

5 Estimation Results

5.1 The Excess Sensitivity of Young and Small Firms to the Crisis

We start our analysis by examining whether the Greek financial crisis was more disruptive to young (relative to mature) and small (relative to large) firms. To this end, we estimate the econometric specification (4.1'), presented in the previous section. Table 2 reports the estimation results for the econometric specification (4.1'). Two observations emerge. First, young and small firms grow faster than their mature and large counterparts (as indicated by the positive sign of the coefficients of the *Young*, *Small* and *Young* \times *Small* variables). Second, the crisis hit hardest the growth rates of young (relative to mature) and of small (relative to large) firms (as indicated by the negative signs of *Young* \times *Crisis* and *Small* \times *Crisis*).

***** Insert Table 2 here *****

To quantify the excess decline in the growth rates of young (relative to mature) and of small (relative to large) firms, we estimate expressions (4.1a) and (4.1b), based on the estimation results of model (4.1'). Table 3, Panel A, reports the relevant estimates. As we can see, the Greek Depression was particularly destructive for young firms. After controlling for size effects, we find that the decline in sales growth rate of Greek firms due to the crisis was about 6.6 percentage points larger in young firms than in their mature counterparts. This finding lies in accordance with empirical evidence for the US Great Recession (Fort et al. (2014) and Siemer (2019)). The Greek Depression was even more disruptive for small relative to large firms, after controlling for age effects. We find that the decline in sales growth rate of Greek firms due to the crisis was about 9.8 percentage points larger in small firms than in their large counterparts. This finding is in line with Crouzet and Mehrotra (2021) which finds that small firms' sales in the US are more sensitive than those of large firms to the business cycle. However, it is in contrast with the findings of Chari et al. (2013) and Kudlyak and Sanchez (2017), according to which small and large firms' sales are equally responsive to recessions.

***** Insert Table 3 here *****

It is important to note that our econometric strategy allows us to estimate the differential crisis effect on young (small) relative to mature (large) firms controlling for size (age) effects. This is a

key element of our analysis since the age-size dependence has been ignored in previous empirical studies that try to quantify the differential impact of aggregate shocks on firms by age and size (see among others Chodorow-Reich, 2014; Duygan-Bump et al. (2015); Siemer, 2019; and Crouzet and Mehrotra, 2021).

To sum up, in accordance with hypothesis H1, the Greek Depression was exceedingly disruptive for young and especially to small firms.

5.2 Potential Drivers of the Excess Sensitivity of Young and Small Firms

Now we turn to the potential drivers of the documented excess sensitivity of young and small firms to the Greek financial crisis. As we explained in Section 3, we focus on two factors that seem to be directly connected to firm age and size. These factors are financing constraints and less favourable short-term unexpected demand shocks that Greek firms may have faced during the financial crisis.

To explore the role of these two factors, we estimate the econometric specification (4.2'), presented in Section 4. Table 4 reports the relevant estimation results. Several observations emerge. First, the crisis was more disruptive (in terms of sales growth) to financially constrained firms (as indicated by the negative sign of $FC \times Crisis$), namely for firms entering the crisis with high leverage (see Section 3.2 for more details). This result is stronger for young than mature firms and for small than large enterprises (as the negative signs of the coefficients of $Young \times FC \times Crisis$ and $Small \times FC \times Crisis$ indicate). Second, the crisis was more disruptive for firms that experienced less favourable unexpected demand shocks (as indicated by the negative sign of the coefficient of $LUD \times Crisis$) (see Section 3.2 for more details on the LUD variable). The effect was stronger for small than large firms (as the negative sign of $Small \times LUD \times Crisis$ indicates). However, it does not seem to be related to firm age (the coefficient of the $Young \times LUD \times Crisis$ is insignificant). Finally, although the crisis was more disruptive to firms that were financially constrained and also faced less favourable demand shocks (the coefficient of $FC \times LUD \times Crisis$ is negative and significant), this effect does not seem to be differentiated by firm age or size (the coefficients of $Young \times FC \times LUD \times Crisis$, $Large \times FC \times LUD \times Crisis$ and $Small \times FC \times LUD \times Crisis$ are insignificant). This means that the excess sensitivity of young (vs. mature) or small (vs. large) firms was not due to an interaction of unexpected demand shocks and credit constraints during the crisis. This leads us to interpret the effect of credit constraints as the effect of credit-supply shocks.

***** Insert Table 4 here *****

We now move to a more in-depth analysis of the role of the two factors in the excess sensitivity of young and of small firms during the Greek Depression.

5.2.1 The Role of Credit Supply

Both theoretical and empirical studies emphasize a variety of mechanisms whereby recessions, including ones not originating in the financial sector, could be worsened by the presence of financial frictions (see for instance: [Gertler and Gilchrist, 1994](#); [Rajan and Zingales, 1995](#); [Whited and Wu, 2006](#); [Chodorow-Reich, 2014](#); [Duygan-Bump et al., 2015](#); [Fakos et al. \(2022\)](#), and [Siemer, 2019](#)). We start our analysis by investigating whether part of the asymmetric sensitivities by firm size and age that we have documented in section 5.1, is driven by credit supply shocks (testable hypothesis H2).

In Table 3, Panel B, we present the estimates for expressions (4.2a) and (4.2b), based on the estimation results of model (4.2'). $\hat{\theta}_{age}^{Cr,FCs}$ indicates that the differential impact of the crisis on the sales growth of young versus mature firms is 7.8 percentage points larger in credit-constrained firms. Thus, part of the excess sensitivity of young firms to the crisis compared to mature firms is due to the credit-supply shock buffeting constrained firms. Similarly, $\hat{\theta}_{size}^{Cr,FCs}$ shows that the differential impact of the crisis on the sales growth of small versus large firms is 5 percentage points larger in credit-constrained firms. Part of the excess sensitivity of small firms to the crisis compared to large firms is due to the credit-supply shock buffeting constrained firms. Note that this differential (5 p.p.) is smaller than the excess sensitivity of small vs. large firms displayed in Table 3 (9.8 p.p.). This indicates that there are other important drivers of the relative crisis effects by firm size, beyond credit frictions. None the less, the triple differences in Panel B of Table 3 are statistically significant and economically large providing evidence for hypothesis H2: that credit supply had real effects and explains a large part of the excess sensitivity of small and especially of young firms during the Greek Depression.

These findings are in line with studies that argue that differential responses of firms to aggregate shocks are connected with a financial accelerator mechanism ([Chaney et al., 2012](#); [Duygan-Bump et al., 2015](#); [Zwick and Mahon, 2017](#); and [Siemer, 2019](#)). Our findings are in contrast with those of [Crouzet and Mehrotra \(2021\)](#) for the US economy who find that the differences in cyclicalities of firms by size are largely unrelated to financial strength.

5.2.2 The Role of Unexpected Demand Shocks

The second factor we examine is idiosyncratic demand shocks. Following the approach of [Kumar and Chang \(2019\)](#), we explore the role played during the Greek Depression by the contraction in short-term demand on the cross-sectional heterogeneity of firm outcomes.

In Table 3, Panel C, we present the estimates for expressions (4.2a) and (4.2b), based on the estimation results of model (4.2'). The lack of statistical significance for $\hat{\theta}_{age}^{Cr,LUD}$ indicates that the documented excess sensitivity of young firms to the crisis cannot be explained by less favourable unexpected demand shocks. In contrast, $\hat{\theta}_{size}^{Cr,LUD}$ shows that the differential impact of the crisis on the sales growth of small versus large firms is 8.4 percentage points larger in firms that experienced lower unexpected demand shocks. It is important to note that our econometric

methodology allows us to quantify the effects of credit constraints controlling for the effect of unexpected demand shocks and vice versa. Therefore, credit constraints and demand shocks constitute two important drivers of the documented excess sensitivity of small firms to the Greek financial crisis. On the contrary, the excess sensitivity of young firms is only credit- and not demand-driven. Therefore, we do not find evidence for the first part of H3, but we do for the second one. Moreover, unexpected demand shocks seem to have played a more important role than credit constraints in the excess decline in small firms' growth rates during the Greek crisis.

6 Sensitivity Analysis

In this section, we examine the robustness of our results. To this end, we perform four sensitivity exercises. First, we examine whether our results are robust to using an alternative measure for financing constraints. Second, we explore whether our results are robust to using an alternative approach to measure changes in unexpected demand shocks. Third, we examine whether our results are robust to using a different method for correcting selection bias. Finally, we examine whether our results are robust to using alternative measures for firm growth rates.

6.1 An Alternative Measure for Financing Constraints

In our baseline analysis, we used financial leverage (the debt-to-assets ratio) as a proxy for the credit constraints that firms may face. To ensure the robustness of our results, we re-estimate the econometric specification (4.2') using the [Rajan and Zingales \(1998\)](#) industry-level measure for external financial dependence - that we described in Section 3.2 - as an alternative proxy for firm financing constraints.

Table 5 (Robustness Check I) displays the new estimates of expressions (4.2a) and (4.2b) for the two potential drivers (financing constraints and unexpected demand shocks) of the differential impact of the crisis on firms by age and size that we documented in Section 5.1. As one may see, using the [Rajan and Zingales \(1998\)](#) measure as a proxy for financing constraints leads to somehow lower but quite similar contributions of financing constraints to the age and size differentials in growth rates compared with the baseline contributions obtained in Section 5.1.

***** Insert Table 5 here *****

6.2 Alternative Measurement of Unexpected Demand Shocks

In our baseline analysis, we recovered the unexpected demand shocks through the estimation of equation (3.6) following the approach in [Kumar and Chang \(2019\)](#). An alternative approach is to directly recover changes in short-term demand shocks using equation (3.7). Both approaches have advantages and limitations (see Section 3.2 for more details). To check the robustness of our results, we re-estimate (4.2') using these "constructed" changes in unexpected demand shocks

from equation (3.7) instead of the “estimated” changes from equation (3.6) that we utilized in our baseline analysis.

Table 5 (Robustness Check II) displays the new estimates of expressions (4.2a) and (4.2b). These capture the contribution of financing constraints and unexpected demand shocks to the differential impact of the crisis on firms by age and size. The estimates are quite close to the baseline estimates obtained in Section 5.1.

6.3 Alternative Correction for Selection and Sampling Bias

We employed the method of Olley and Pakes (1996) in order to deal with endogenous firm selection due to entry and exit and sampling bias due to the construction of our dataset. We examine the robustness of this approach by re-estimating econometric specifications (4.1') and (4.2') using Heckman's (1979) two-step approach for selection bias correction. More specifically, following Wooldridge's (2010) generalization of Heckman's (1979) methodology for panel data we can approximate the *bias term* in equations (4.1') and (4.2') as follows:

$$E[\xi_{i,t} | X_{i,t}^{(1)}, y_{i,t} = 1] \approx \gamma_1 IMR_{i,t} \quad (6.1a)$$

$$E[\varepsilon_{i,t} | X_{i,t}^{(2)}, y_{i,t} = 1] \approx \gamma_2 IMR_{i,t} \quad (6.1b)$$

where γ_1 and γ_2 are constant parameters. $IMR_{i,t}$ is the inverse Mill's ratio given by

$$IMR_{i,t} = \frac{\varphi_{i,t}}{\Phi_{i,t}}$$

where $\varphi_{i,t}$ and $\Phi_{i,t}$ denote the survival probability of firm i in year t and its probability density, respectively. Under suitable assumptions, we can obtain consistent estimates of these quantities by using the Probit model (4.4), described in section 4.

We re-estimate econometric specifications (4.1') and (4.2') using Heckman's (1979) methodology to correct for selection and sampling biases. The results, contained in Table 5 (Robustness Check III), are similar with those of the baseline approach (Table 3).

6.4 An Alternative Measure for Firm Growth Rates

There are different formulas for measuring firm growth rates. In a list of 10 alternative measures for growth rates surveyed by Tornqvist et al. (1985), the “log difference” measure was found to be the most preferable measure of relative change as it is the only one that is symmetric, additive and normed. According to the logarithmic measure, the annual firm growth rate, $g_{i,t}$, is defined as the logarithmic difference $\Delta \ln S_{i,t}$ where $S_{i,t}$ denotes the size of firm i at period t (i.e. the gross sales of firm i at period $t - 1$, deflated by the relevant Producer Price Index).

However, an important drawback of log differences as a measure of relative change is that it is not defined for exiting and entering firms with $S_{i,t} = 0$ and $S_{i,t-1} = 0$, respectively, restricting our sample.¹⁶ For this reason, we chose to utilize the Davis et al. (1996) measure for firm growth in this study (see Section 3.2 for more details) that accommodates firm entry and exit.

We check the robustness of our results by repeating our analysis utilizing the “log differences” measure for firm growth rates. The corresponding results can be found in Table 5 (Robustness Check IV). Our baseline results are robust to this alternative measure.

7 Aggregate Implications of the Excess Sensitivity of Young and Small Firms

Following the approach of Chodorow-Reich (2014) and Siemer (2019), we can use the estimates from sections 5.1 and 5.2 in order to obtain the aggregate implications of the excess sensitivity of young and small firms during the Greek Depression and also assess the role played by financing constraints and unexpected demand shocks.

To quantify the aggregate effects of young and of small firms’ excess decline, we construct counterfactual paths for aggregate sales growth assuming that the responses of Greek firms to the financial crisis are the same across the firm age and size distributions. We then compare these counterfactuals against realized aggregate sales growth. To this end, the following assumption is necessary:

Assumption 1 (Partial equilibrium): The overall effect on gross output is the sum of the direct sales effects on each firm.

The above assumption rules out any general equilibrium effects through price adjustments. Taking such effects into account would require a general equilibrium model.

Given the assumption above, we can proceed to the computation of the aggregate implications of the estimates in section 5. We have argued that these estimates identify the differential effect of the Greek financial crisis on small relative to large and on young relative to mature firms. We calculate the aggregate implications of the financial crisis by comparing the sales evolution in the (fitted) data with that in a counterfactual in which we assume that the crisis affected small firms in the same way as large firms, i.e. the differential crisis effect is zero (and similarly for young and mature firms). Define the counterfactual growth rate of a firm i in class j , $j \in \{\text{small during the crisis, young during the crisis}\}$, as:

$$\tilde{g}_{i,t}^{j,(1)} = \hat{g}_{i,t}^{j,(1)} + \left| \hat{\theta}_j^{Cr} \right| \tag{7.1}$$

¹⁶The available observations in our sample is 276,636. The exclusion of entrants and exiters decreases the number of observations to 267,487.

where $\hat{g}_{i,t}^{j,(1)}$ denotes the predicted value of the growth rate of firm i at year t from the regression of firm type j (obtained from econometric specification (4.1')), and $\hat{\theta}_j^{Cr}$ is the corresponding point estimate of the differential crisis effect on young versus mature (estimate for expression (4.1a)) or on small versus large (estimate for expression 4.1b)) firms. For all firms that do not belong in any class j , the counterfactual growth rate equals the fitted growth rate. The same holds for young or small firms for the years before the eruption of the crisis (1998-2009).

Figure 4 provides a graphical representation of the counterfactual exercise that equation 7.1 executes. It compares the dynamic patterns of the average fitted growth rates $\hat{g}_{i,t}^{(1)}$ obtained from the econometric specification (4.1') with the dynamic patterns of the average counterfactual growth rates obtained by equation (7.1) during the Greek Depression (the counterfactual coincide with the fitted growth rates during the pre-crisis era). As we can see, the counterfactual growth rates are nothing else than the fitted growth rates after the neutralization of the effects of the excess sensitivity of young or of small firms as they are captured by expressions (4.1a)) and 4.1b). The neutralization of these effects leads to an upward parallel shift of fitted-growth curve. Moreover, the patterns of the fitted growth rates are very similar with the patterns of the actual growth rates, presented in Figure 2, making us confident for the accuracy of model (4.1').

***** Insert Figure 4 here *****

After the construction of the counterfactual growth rate, we can create the counterfactual sales series as follows:

$$\tilde{s}_{i,t}^{(1)} = M(\tilde{g}_{i,t}^{(1)}, \tilde{s}_{i,t-1}^{(1)}) \quad (7.2)$$

where, as in Chodorow-Reich (2014), M denotes the mapping from symmetric annual growth rates to the end-period t level of sales:

$$M[x, y] = \frac{1 + 0.5x}{1 - 0.5x}y \quad (7.3)$$

In order to calculate the counterfactual sales series for the years of the Greek financial crisis (2010-2014), we use as initial value the real value of sales in the year before the eruption of the crisis: $\tilde{s}_{i,t_0}^{(1)} = s_{i,2009}$.

In the same spirit, the fitted value end-period sales level can be computed as: $\hat{s}_{i,t}^{(1)} = M(\hat{g}_{i,t}^{(1)}, \hat{s}_{i,t-1}^{(1)})$.

The aggregate effect of the differential impact of the crisis on young relative to mature or on small relative to large firms can be calculated as follows:

$$\frac{\sum_{i \in j} (\tilde{s}_{i,2014}^{j,(1)} - \hat{s}_{i,2014}^{j,(1)})}{\sum_i (s_{i,2009} - s_{i,2014})} \quad (7.4)$$

In the same spirit, we can compute the contribution of financial constraints and unexpected demand shocks to the aggregate differential crisis effect by age and size, we documented above.

We need to make some extra assumptions. First, in order to compute the aggregate implications of credit-supply shocks (as captured by firm financing constraints) and of unexpected demand shocks, we need to assume the existence of an unconstrained category of firms, as in [Chodorow-Reich \(2014\)](#). For the case of unexpected demand shocks the unconstrained category is very clear (firms that did not experience less favourable short-term demand shocks). For the case of financing constraints we make the following assumption:

Assumption 2 (Low-leverage firms are unconstrained): Firms entering the financial crisis with low financial leverage (namely firms with 2007 leverage below the median of the distribution) are unconstrained and financing constraints affect firms only through high leverage.

Assumption 2 is quite conservative. If low-leveraged firms were also hit by a credit supply shock then the estimates will understate the true effect of the credit supply shock.

Second, due to the presence of entry and exit in the ICAP data, we make the following additional assumption for the calculation of aggregate implications, following [Siemer \(2019\)](#):

Assumption 3:

- (a) (No credit-supply effect on start-ups): Credit-supply shocks did not affect start-ups or potential start-ups.
- (b) (No unexpected demand effect on start-ups): Unexpected demand shocks did not affect start-ups or potential start-ups.

Assumption 3 is required for two reasons. First, potential entrants are not observed and any effect of financing constraints and unexpected demand shocks on changes in the decisions of entrants can not be taken into account to compute aggregate implications. Second, while entrants are observed, they get assigned a growth rate of +2, the upper bound of the DHS growth rate. Entrants are, by construction, at the upper bound of the DHS growth rate and thus cannot be assigned a higher growth rate in a counterfactual. Taking effects on start-ups into account would require an empirical model of start-up decisions, something that is beyond the scope of this paper. Assumption 3 means that the calculated aggregate effects of credit-supply and unexpected-demand shocks are likely understated. Credit-supply shocks and unexpected demand shocks possibly affected negatively entrants as well as potential entrants.

As before, the counterfactual growth rate can be defined as:

$$\tilde{g}_{i,t}^{j,(2)} = \hat{g}_{i,t}^{j,(2)} + \left| \hat{\theta}_j^{Cr,F} \right|, F \in \{FC, LUD\} \quad (7.1')$$

where $\hat{g}_{i,t}^{j,(2)}$ denotes the predicted growth rate of firm i at year t from the regression of firm type $j \in \{\text{small and financially constrained during the crisis, young and financially constrained during the crisis, small with less favourable unexpected demand shocks during the crisis, young with less}$

favourable unexpected demand shocks during the crisis}, obtained from equation (4.2'). $\hat{\theta}_j^{Cr,F}$ is the corresponding point estimate of the differential response of small (young) firms to the crisis due to financing constraints (FC) or less favourable unexpected demand shocks (LUD), obtained from expressions (4.2a) and (4.2b).

Assuming the same mapping function as before, the aggregate effect of each factor F through young or small firms can be calculated as follows:

$$\frac{\sum_{i \in j} (\tilde{s}_{i,2014}^{j,F,(2)} - \hat{s}_{i,2014}^{j,F,(2)})}{\sum_i (s_{i,2010} - s_{i,2014})} \quad (7.4')$$

Table 6 reports the estimates for expressions (7.4) and (7.4'). Total (gross) output of the Greek economy was reduced by 23% during the Greek Depression (from 2009 to 2014). The excess sensitivity of young (relative to mature) firms to the crisis accounts for about 13.7% of this reduction, while the excess decline in small (relative to large) firms accounts for about 13% of this reduction. Therefore, the aggregate effect of the differential impact of the Greek financial crisis on small relative to large and especially on young relative to mature firms is quantitatively important, accounting together for about 23.7% of the total reduction of Greek economy's gross output due to the financial crisis. Now let's turn to the origins of this aggregate effect.

We start with the sources of the aggregate effect of the excess decline in young firms' sales growth during the crisis. About 7.4% of the reduction of Greek economy's gross output stems from the financing constraints that young firms face. This means that more than half ($54.3\% = 7.4/13.7$) of the aggregate effect of the excess decline in young firms during the Greek Depression stems from the credit constraints that these firms face. However, unexpected demand shocks were found to play no role in the excess decline of young firms (see section 5.2).

Now, let's turn to the sources of small firms' aggregate effect. About 2.7% of the reduction of Greek economy's gross output stems from the financing constraints that small firms may have faced during the crisis. This means that credit constraints can explain about the 21% of the aggregate effect of the excess decline in small firms during the Greek Depression. However, demand play a very important role in this aggregate effect as well. About 2.8% of the reduction of Greek economy's gross output can be attributed to less favourable short-term demand shocks of small firms. This means that about $21.5\% = 2.8/13$ of the aggregate effect of the excess sensitivity of small firms during the Greek financial crisis can be explained by less favourable unexpected demand shocks that small firms experienced. It is important to note that our econometric methodology enables us to estimate the contribution of credit-supply shocks controlling for the effects of unexpected-demand shocks and vice versa. Therefore, our results indicate that credit-supply and unexpected demand shocks explain 42% of the aggregate effect of the excess decline in small firms during the Greek Depression.

***** Insert Table 6 here *****

8 Conclusions

Using the Greek Depression as an economic laboratory, this study brings new evidence on the differential responses of firms to financial crises by age and size.

First, we document that the Greek Depression was more destructive for young (relative to mature) and for small (relative to large) enterprises. The Greek financial crisis reduced firm sales growth by 9.8 percentage points in small relative to large firms, and by 6.6 in young relative to mature firms. Our econometric framework allows us to quantify the differential impact of the crisis by age controlling for size effects and vice versa.

Then, we explore whether this excess sensitivity of young and of small firms to the crisis is credit- or demand-driven. Specifically, we explore the role of financing constraints along with that of unfavorable short-term demand shocks that firms have faced during the crisis. First, we show that both factors are related to the changes in the firm growth patterns due to the financial crisis across the age and size distributions. Second, we demonstrate that although the excess decline in small firms' growth rates during the Greek financial crisis is both credit- and demand-driven, the excess sensitivity of young firms to the crisis stems only from the financial distress they faced during the crisis.

Finally, we analyze the aggregate implications of our findings. We find that the excess decline in the growth rates of small firms accounts for about 13% of the reduction of the total output of the Greek economy due to the crisis, with this percentage being almost equally distributed among the two factors mentioned above, while the excess decline in the growth rates of young firms accounts for about 13.7% of this reduction, with more than the half (54.3%) of this effect stemming from financing constraints.

Our findings inform the policy debate on appropriate public policy for the support of enterprises during downturns and crises. This has become even more important in the aftermath of the global financial crisis that erupted in 2008 or during the COVID-19 crisis. Governmental policies that attempt to alleviate credit constraints faced by small and medium-sized enterprises (SMEs hereafter) are widely adopted across countries.¹⁷ Until now most public policy action has targeted businesses of a certain size, neglecting the role of age.¹⁸ Such policies will likely have limited success in improving net job creation challenges that start-ups and young firms face. We find that,

¹⁷In USA, for instance, the **Small Business Administration (SBA)** provides support in small businesses through free business counseling, loan guarantees and help to win federal or government contracts. In EU, the **Enterprise Europe Network (EEN)** provides support to SMEs on access to market information, overcoming legal obstacles, and identifying potential business partners across Europe. Also, the **European Investment Fund**, through the European Investment Fund, facilitates the access of European SMEs to finance through a wide range of selected financial intermediaries. In Greece the program "**Roots**" of Athens Stock Exchange (ATHEX), in cooperation with the American-Hellenic Chamber of Commerce, was activated in 2018 in order to enhance the access of innovative Greek SMEs to external financing not through Greek banks but through the capital markets. The program combines advisory and training opportunities with access to an international network of experts to enable SMEs to reach the point of investment-readiness.

¹⁸For instance, from the **Horizon 2020 Programme**, which is the biggest EU Research and Innovation program ever, a 3 billion fund (the so called "European Innovation Council-EIC Accelerator" or "SMEs Instrument") was and will be provided for the support of innovative SMEs across Europe. However, no age limit had been set.

at least for the case of Greece, the financing constraints that young firms face have more important macroeconomic implications than those of small firms. Therefore, age should not be ignored by policymakers.¹⁹

Moreover, we find that unexpected demand shocks faced by small firms also have important aggregate implications. Therefore, public policies aimed at supporting SMEs should also focus on demand-driven interventions. This may include direct stimulus of demand through tax cuts and subsidies or innovation-strengthening measures.

¹⁹A positive step towards this direction was the creation of the “Startup Europe” in 2011, of the “Startup Europe Partnership” in 2014 and of the “Startup Europe Week” in 2015. All of them were initiatives of the European Commission. All these initiatives try to facilitate the creation of startups across Europe and their transformation into scale-ups by linking them with investors and stock exchanges. However, none of these organizations includes direct EU funding in its toolbox to achieve its goals.

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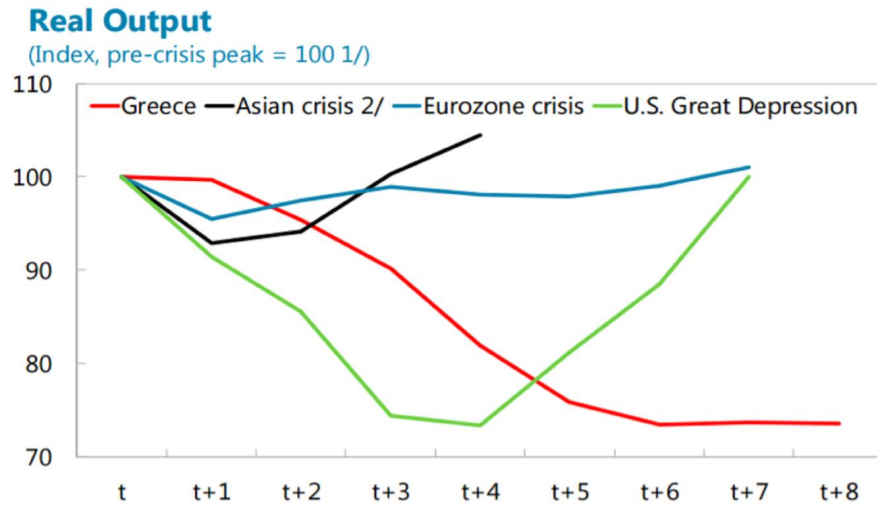
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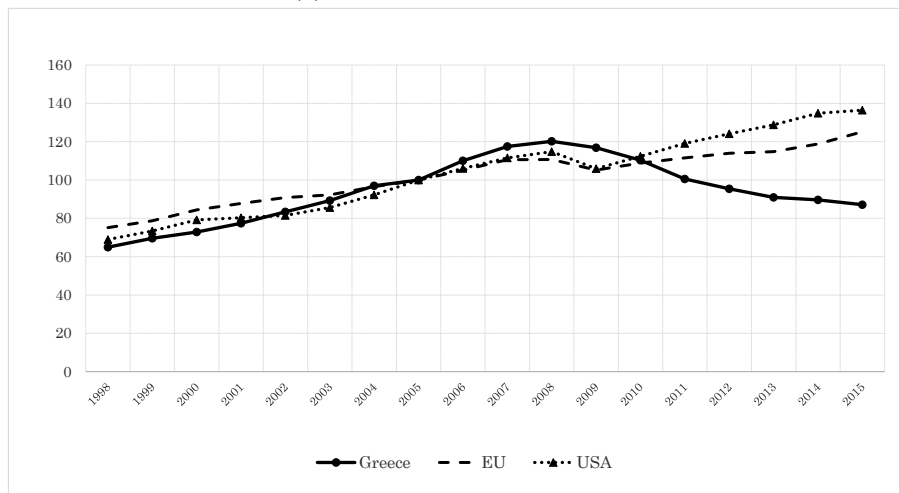
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Figures



(a) Greek crisis VS other crises



(b) Evolution of Gross Output

Notes: (i) Pre-crisis peaks are 2007 for Greece, 1997 for Asian crisis, 2008 for Eurozone crisis, and 1929 for Great Depression, (ii) Asian Crisis includes Indonesia, Republic of Korea, and Thailand, (iii) Gross output is in millions USD.

Sources: (a) International Monetary Fund, 2018 Country Report No. 18/248, (b) Eurostat.

Figure 1: The Greek Depression

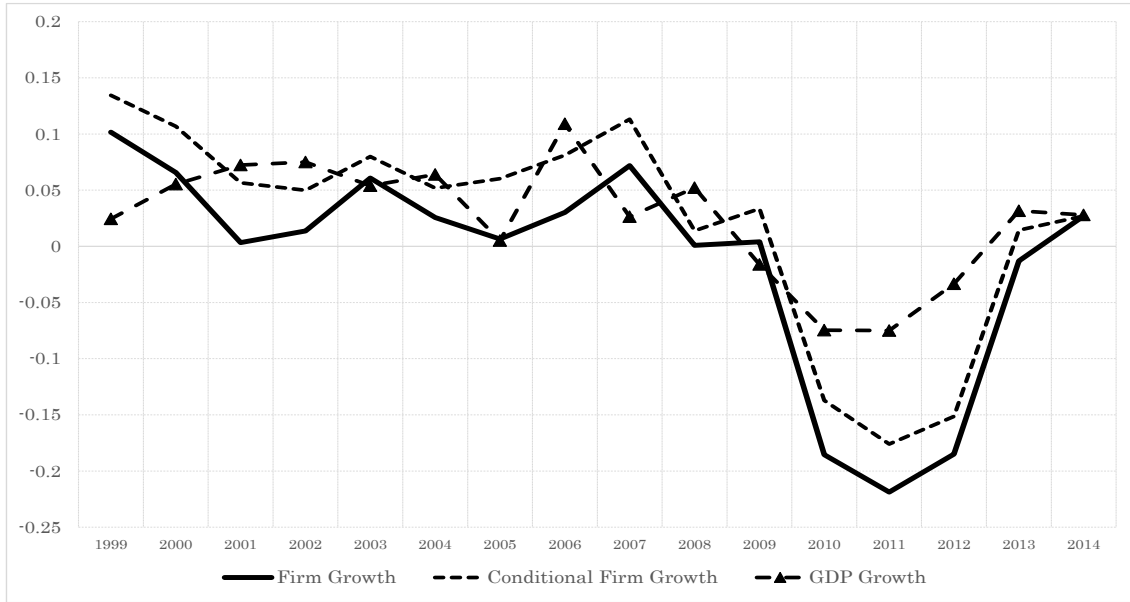


Figure 2: Dynamic Patterns of Firm Growth

Notes: This figure presents the dynamic patterns of average annual firm sales growth rates of Greek firms for the time period 1998-2014. To investigate whether the growth rates of the firm-level data resemble the growth path of the Greek economy, we also include the growth rates of the Gross Domestic Product (GDP hereafter) annual time series, as reported in the OECD Database.

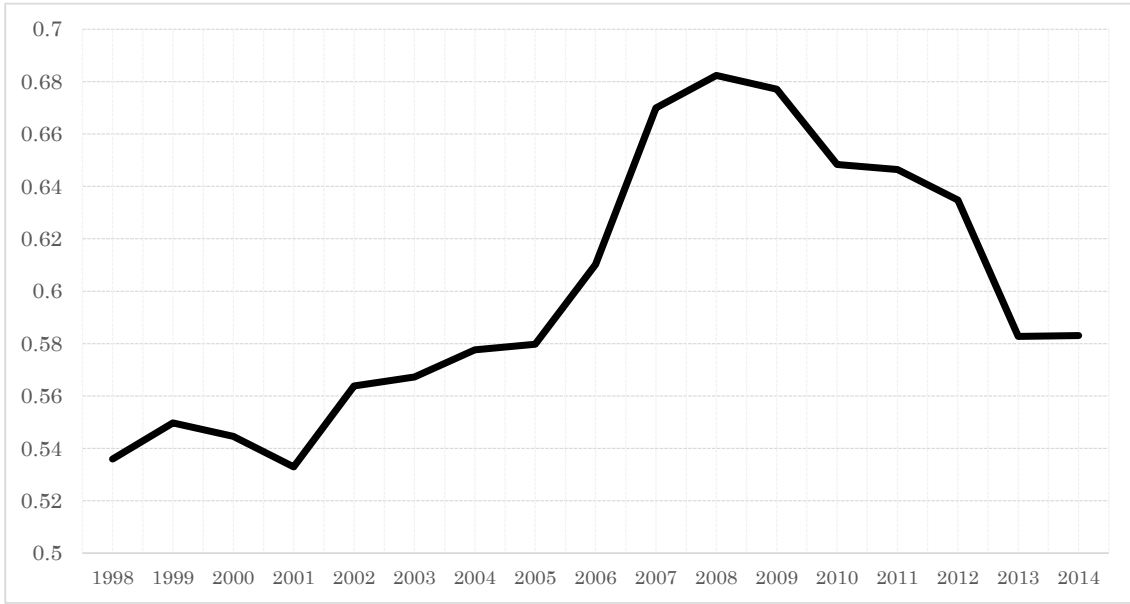


Figure 3: Dynamic Patterns of Financial Leverage

Notes: This figure presents the dynamic patterns of average financial leverage of Greek firms for the time period 1998-2014. We define financial leverage as the debt-to-assets ratio.

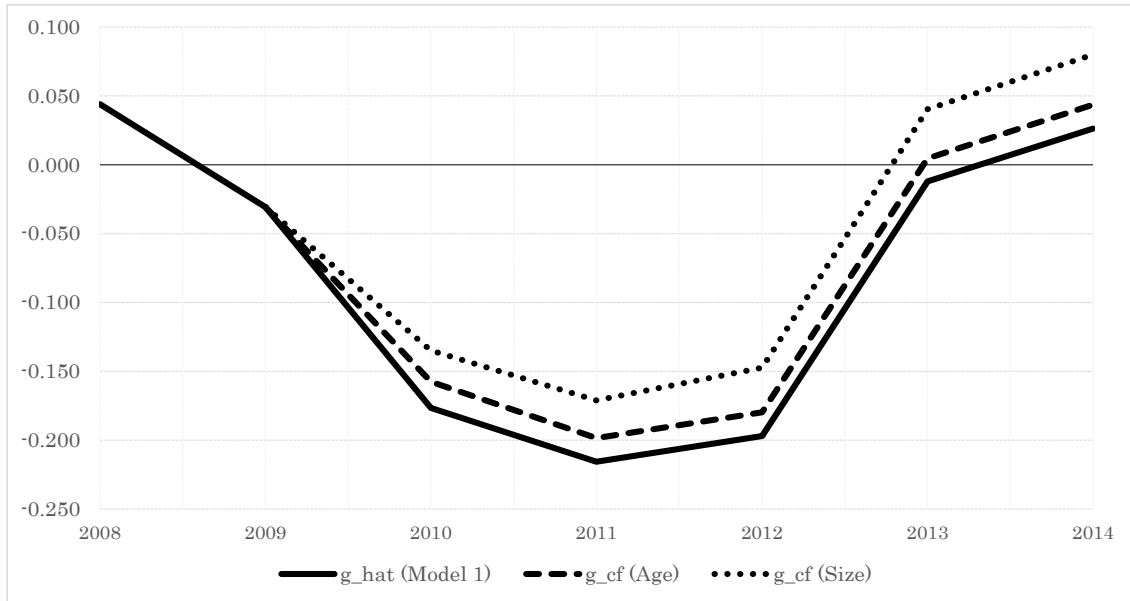


Figure 4: Dynamic Patterns of Counterfactual and Fitted Growth Rates

Notes: This figure compares the dynamic patterns of the average fitted growth rates $\hat{g}_{i,t}^{(1)}$ obtained from the econometric specification (4.1') (solid line) with the dynamic patterns of the average counterfactual growth rates obtained by equation (7.1) for young (dashed line) and for small (dotted line) firms.

Tables

Statistics	$g_{i,t}$	$Sales_{i,t}$	$Age_{i,t}$	$(Debt/Assets)_{i,t}$	$\Delta\hat{\zeta}_{i,t}$
	Pre-crisis Period (1998-2009)				
Obs	179,814				
Mean	0.174	6.202	15	0.597	-0.005
SD	0.464	67.800	13	0.344	0.470
p10	-0.390	0.083	3	0.121	-0.194
Median	0.027	0.924	11	0.626	0.000
p90	1.089	7.607	31	0.940	0.153
	Crisis Period (2010-2014)				
Obs	96,822				
Mean	-0.125	5.254	17	0.496	-0.059
SD	0.661	91.700	14	0.411	0.682
p10	-0.637	0.062	4	0.097	-0.253
Median	-0.089	0.712	15	0.579	0.000
p90	0.333	6.657	35	0.987	0.141

Notes: This table presents some descriptive statistics (mean, standard deviation, median, 10th and 90th percentiles, and the number of observations) for the main variables we employ in this study, described in Section 2. Specifically, we analyze the following variables: DHS firm growth, gross sales (in millions euro), firm age, financial leverage (defined as the ratio of debt to total assets, and year-on-year change in firm-level unexpected demand shocks (see Section 3.2 for the corresponding definitions).

Table 1: Descriptive Statistics

Dependent Variable: Annual Sales Growth			
	Coefficient	SE	P-value
Young	0.055	0.003	0.000
Large	-0.012	0.003	0.000
Small	0.072	0.003	0.000
Young x Large	0.008	0.009	0.362
Young x Small	0.130	0.006	0.000
Crisis	-0.075	0.005	0.000
Young x Crisis	-0.053	0.011	0.000
Large x Crisis	0.044	0.005	0.000
Small x Crisis	-0.045	0.004	0.000
Young x Large x Crisis	0.007	0.026	0.791
Young x Small x Crisis	-0.007	0.015	0.626
Sectoral FEs	yes		
Location FEs	yes		
Constant	0.041	0.017	0.014
Selection Bias Correction Term	-0.112	0.018	0.000
Observations	276,636		

Notes: This Table reports the estimation results from model (4.1'). Standard errors (SE) are clustered by firm.

Table 2: Estimation Results for Model (4.1')

	Estimated Expression	Young VS Mature	Small VS Large
Panel A	θ^{Cr} (4.1a for age, 4.1b for size)	-0.066*** (0.007)	-0.098*** (0.006)
Panel B	$\theta^{Cr,FCs}$ (4.2a for age, 4.2b for size)	-0.078*** (0.018)	-0.050*** (0.010)
Panel C	$\theta^{Cr,LUD}$ (4.2a for age, 4.2b for size)	-0.016 (0.019)	-0.084*** (0.010)

Notes: In this table, we quantify the differential effect of the Greek financial crisis on young relative to mature firms and on small relative to large firms along with the role of financing constraints and unexpected demand shocks in this effect. To quantify the differential crisis effect, we compute the double difference between the marginal effects of mature and young (expression (4.1a) and of large and small (4.1b) firms on firm growth, between the boom and the crisis periods, based on the estimation results of econometric specification (4.1'). To quantify the the role of financing constraints (FCs) and unexpected demand shocks (LUD) in the differential effect of the Greek financial crisis, we compute the triple difference between the marginal effects of mature and young (or large and small) firms on firm growth, between the boom and the crisis periods, between financially constrained and not financially constrained firms or between firms with lower (less favourable) short-term demand shocks or not (expressions (4.2a) and (4.2b)), based on the estimation results of augmented econometric specification (4.2'). Standard errors are clustered by firm and calculated according to Delta Method (Dorfman, 1938).

Table 3: Quantifying the Excess Sensitivity of Young and Small Firms to the Greek Depression: the Role of Financing Constraints and Unexpected Demand Shocks

Dependent Variable: Annual Sales Growth			
	Coefficient	SE	P-value
Young	0.058	0.008	0.000
Large	-0.042	0.006	0.000
Small	0.086	0.004	0.000
Young x Large	0.048	0.025	0.050
Young x Small	0.128	0.012	0.000
FC	0.032	0.004	0.000
Young x FC	0.022	0.010	0.025
Large x FC	0.000	0.007	0.960
Small x FC	0.055	0.007	0.000
Young x Large x FC	-0.069	0.028	0.014
Young x Small x FC	-0.017	0.016	0.288
LUD	-0.202	0.004	0.000
Young x LUD	-0.051	0.011	0.000
Large x LUD	0.060	0.008	0.000
Small x LUD	-0.081	0.007	0.000
Young x Large x LUD	-0.009	0.035	0.801
Young x Small x LUD	-0.053	0.019	0.005
FC x LUD	0.008	0.006	0.142
Young x FC x LUD	-0.010	0.014	0.481
Large x FC x LUD	-0.010	0.010	0.358
Small x FC x LUD	-0.057	0.012	0.000
Young x Large x FC x LUD	0.032	0.040	0.413
Young x Small x FC x LUD	0.012	0.026	0.641
Crisis	-0.023	0.006	0.000
Young x Crisis	-0.044	0.022	0.050
Large x Crisis	0.026	0.009	0.004
Small x Crisis	-0.002	0.007	0.756
Young x Large x Crisis	0.018	0.054	0.737
Young x Small x Crisis	-0.047	0.028	0.090
FC x Crisis	-0.047	0.006	0.000
Young x FC x Crisis	-0.551	0.033	0.000
Large x FC x Crisis	-0.001	0.012	0.917
Small x FC x Crisis	-0.034	0.011	0.002
Young x Large x FC x Crisis	0.024	0.077	0.754
Young x Small x FC x Crisis	-0.188	0.045	0.000
LUD x Crisis	-0.043	0.007	0.000
Young x LUD x Crisis	-0.019	0.031	0.545
Large x LUD x Crisis	0.026	0.013	0.048
Small x LUD x Crisis	-0.076	0.011	0.000
Young x Large x LUD x Crisis	-0.077	0.083	0.350
Young x Small x LUD x Crisis	-0.006	0.042	0.879
FC x LUD x Crisis	-0.026	0.010	0.007
Young x FC x LUD x Crisis	-0.069	0.047	0.143
Large x FC x LUD x Crisis	0.011	0.018	0.529
Small x FC x LUD x Crisis	-0.019	0.018	0.293
Young x Large x FC x LUD x Crisis	0.012	0.123	0.924
Young x Small x FC x LUD x Crisis	-0.082	0.070	0.279
Sectoral FEs	yes		
Location FEs	yes		
Constant	-0.061	0.019	0.000
Selection Bias Correction Term	0.167	0.017	0.000
Observations		276,636	

Notes: This Table reports the estimation results from model (4.2'). Standard errors (SE) are clustered by firm.

Table 4: Estimation Results for Model (4.2')

Estimated Expression	Baseline Results	Robustness Check I	Robustness Check II	Robustness Check III	Robustness Check IV
θ_{age}^{Cr} (expression 4.1a)	-0.066*** (0.007)	same as baseline	same as baseline	-0.070*** (0.006)	-0.085*** (0.010)
θ_{size}^{Cr} (expression 4.1b)	-0.098*** (0.006)	same as baseline	same as baseline	-0.109*** (0.006)	-0.161*** (0.008)
$\theta_{age}^{Cr,FCs}$ (expression 4.2a)	-0.078*** (0.018)	-0.047*** (0.015)	-0.079*** (0.019)	-0.047*** (0.015)	0.103*** (0.026)
$\theta_{size}^{Cr,FCs}$ (expression 4.2b)	-0.050*** (0.010)	-0.034*** (0.010)	-0.049*** (0.010)	-0.066*** (0.013)	-0.060*** (0.015)
$\theta_{age}^{Cr,LUD}$ (expression 4.2a)	-0.016 (0.019)	-0.004 (0.015)	-0.011 (0.017)	-0.030 (0.026)	-0.038 (0.024)
$\theta_{size}^{Cr,LUD}$ (expression 4.2b)	-0.084*** (0.010)	-0.095*** (0.011)	-0.086*** (0.010)	-0.076*** (0.013)	-0.110*** (0.015)
Observations	276,636	same as baseline	same as baseline	same as baseline	267,487

Notes: In this table, we present the results for the four robustness check exercises, described in sections 6.1-6.4.

In the first exercise, we repeat our analysis using the [Rajan and Zingales' \(1998\)](#) industry-level measure for external financial dependence as an alternative proxy for financial conditions, as we described in Section 6.1. In the second exercise, we repeat our analysis using an alternative measurement approach for the changes in the short-term unexpected demand shocks, as described in Section 6.2. In the third exercise, we repeat our analysis using the [Heckman's \(1979\)](#) method for correcting the sampling bias, as described in Section 6.3. In the last exercise, we repeat our analysis utilizing the “log differences” measure for firm growth rates, as described in Section 6.4. *, **, *** denote statistical significance at the 10, 5 and 1 percent level respectively. Standard errors are in parentheses. Standard errors are clustered by firm and calculated according to Delta Method ([Dorfman, 1938](#)).

Table 5: Robustness Checks

Gross Output Losses: 2009-2014	
Economy	23%
A. The Role of the Excess Sensitivity of Young and Small Firms	Total Contribution to the Decline in Gross Output (%)
Fall in Gross Output explained by the excess decline in Young Firms	13.70%
Fall in Gross Output explained by the excess decline in Small Firms	13.04%
B. The Drivers	Total Contribution (%)
Fall in Gross Output explained by the financing constraints (FCs) of Young Firms	7.44%
Fall in Gross Output explained by the financing constraints (FCs) of Small Firms	2.72%
Fall in Gross Output explained by less favorable unexpected demand shocks (LUD) of Small Firms	2.80%
	Contribution to the Age or Size Effect
	54.31%
	20.86%
	21.47%

Notes: The table reports the fraction of total gross output losses due to the differential effect of the financial crisis on small (relative to large) and young (relative to mature) firms along with the contributions of financing constraints, unexpected demand and exporting activity to these losses. Aggregate data has been obtained from OECD. Our measures for financing constraints and unexpected demand along with the indicator for exporting activity are described in Section 3.2.

Table 6: Aggregate Implications of the Excess Sensitivity of Young and Small Firms to the Greek Financial Crisis

Appendix

A Data Cleaning

The firm-level data are proprietary and have been obtained from ICAP Group S.A., a private research company that collects and maintains detailed balance sheet and income statement data for S.A. (“Société Anonyme” - companies limited by shares) and Limited-Liability (Ltd) companies in Greece, along with their establishment date, location and ownership status, for credit risk evaluation and management consulting. Our dataset contains firm-level information for approximately 100,657 Greek firms operating in all sectors, except for banks and insurance companies, for the time period 1998 - 2014.

In Greece, the law requires only S.A. and Ltd companies to file annual financial statements with the national business register (the “General Electronic Commercial Registry - G.E.MI.”) and ICAP strives to cover the universe of these firms. Table A1 presents the number of SA and Ltd companies in Greece for the period 2011-2014 along with the number of these firms in our sample. Our sample covers more than 90% of these companies.

Year	ICAP	EL.STAT.	Coverage
2011	56,493	58,632	96%
2012	51,220	54,336	94%
2013	49,769	53,367	93%
2014	54,655	60,788	90%

Source: Greek Statistical Authority (EL.STAT.) and authors’ calculations.

Notes: In this Table, we compare the number of S.A. (i.e. “Société Anonyme” - companies limited by shares) and Ltd (i.e. Limited-Liability) companies in our ICAP dataset with the same numbers as reported by the Greek Statistical Authority (EL.STAT.). Unfortunately, EL.STAT. does not provide data before 2011.

Table A1: Number of S.A. and Ltd Companies in Greece and the coverage in our Sample

We prepare the data for estimation in two stages. First, we clean the data from basic reporting mistakes. Second, we trace and deal with gaps in the data.²⁰ In particular, we implement the following steps to clean the data:

1. We set to missing firm-year observations of gross sales that are zero or negative.
2. We keep firm-year observations that have information on gross sales and establishment date.

²⁰By the term gap we mean a set of missing consecutive firm-year observations.

3. We audit for duplicates in our data.
4. We deal with potential gaps in the data. Due to the high number of missing observations in our sample, in order to ensure the internal consistency of our dataset, we delete the information either of the firms whose sales or employment data has 4 or more gaps, or of the firms with 2 or 3 gaps if the maximum length of a gap is at least 5 consecutive years.

Finally, we trim the top and bottom 1% of firm sales growth rates to minimize the effect of outliers.

After the cleaning process, we conclude to a final unbalanced (due to the entry-exit process of firms) dataset containing 80,597 firms operating in all sectors of the Greek economy.

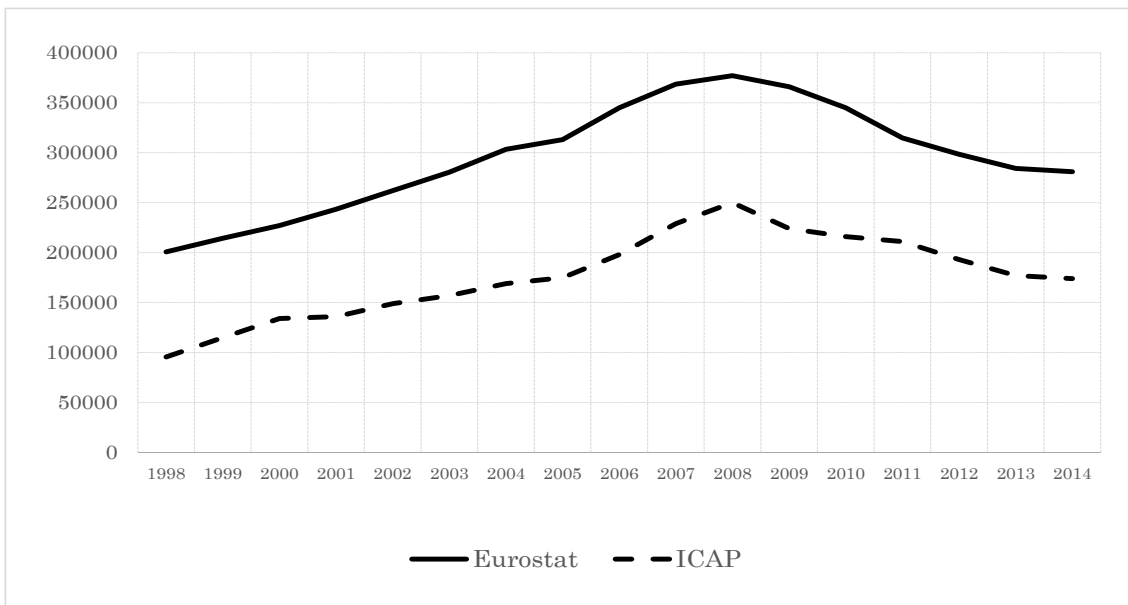


Figure A1: Aggregate Gross Output in ICAP and Eurostat (SBS)

Notes: In this Figure, we compare the evolution of the aggregate gross output in our ICAP dataset with the same aggregate as recorded by Eurostat (SBS).

To the best of our knowledge, our dataset is the largest available firm-level dataset for the Greek economy. A natural question that might arise here is whether our firm-level dataset resembles well the aggregate Greek economy. Table A2 summarizes the coverage in our data compared to the aggregate economy between 1998 and 2014. The columns in the table represent the ratio of gross output aggregated from our sample relative to the aggregate quantity in Eurostat as reported in its Structural Business Statistics (SBS).²¹ The data in Eurostat are from census sources and represent

²¹Gross output is defined by the Bureau of Economic Analysis (BEA) as: “a measure of an industry’s sales or receipts, which can include sales to final users in the economy (GDP) or sales to other industries (intermediate input). At the firm-level, gross output is measured by aggregate gross sales.

the universe of Greek firms. As Table A2 shows, the coverage in our sample is consistently high: it averages roughly 60 percent for the aggregate economy. These coverage statistics are conservative because we drop observations with missing, zero, or negative values for gross sales.

Year	Gross Output
1998	0.48
1999	0.54
2000	0.59
2001	0.56
2002	0.57
2003	0.56
2004	0.56
2005	0.56
2006	0.57
2007	0.62
2008	0.66
2009	0.61
2010	0.63
2011	0.67
2012	0.65
2013	0.62
2014	0.62
Average	0.60

Notes: This Table summarizes the coverage in our data for Greece between 1998 and 2014. The columns in the table represent the ratio of aggregate gross output recorded in our sample relative to the same object in Eurostat as reported by its Structural Business Statistics (SBS). At the firm-level, gross output was measured by aggregate gross sales, deflated by the Producer Price Index (PPI).

Table A2: Coverage in ICAP relative to Eurostat

It is reassuring that the time series properties of the aggregated magnitude for gross output from our raw sample track aggregate data quite well. Figure [A1](#) plots aggregate gross output in our ICAP data set for the time period 1998-2014. It compares the aggregated quantity from our dataset to the respective aggregate as recorded by Eurostat. As we can see, the series in our sample mimic aggregate activity well. The trajectory of total firm sales track closely the trajectory of gross output at the macro-level, respectively. Moreover, the impact of the Greek Depression on the gross output of the aggregate economy is quantitatively similar in our ICAP dataset and in the aggregate data from Eurostat: the gross output declined roughly by 23% from 2009 to 2014.

B Stylized Facts: Firm Growth Patterns by Age and Size before and during the Greek Depression

In this section, we present some stylized facts on the evolution of firm sales growth in Greece during the period 1998-2014, focusing on the impact of firm age and size on these dynamics. As we delineated in the previous Section, this time period can be separated into two phases: a long stretch of euphoric growth (1999 to 2009) and a persistent and severe economic depression (2010 to 2014). We also explore the role of financing constraints and short-term unexpected demand shocks in the dynamic patterns of firm growth across the age and size distributions.

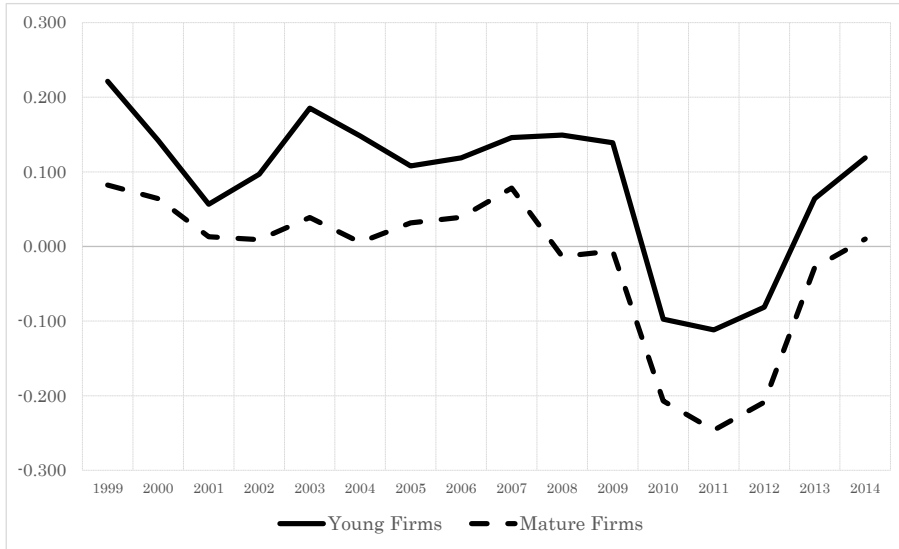
We start our analysis by exploring whether the firm growth vary by firm age and size over the cycle. Figure B1 shows the patterns of firm growth by firm age (panel (a)) and size (panel (b)) groups.²² Two observations emerge from panel (a). First, sales growth rates are significantly higher for young firms than for their mature counterparts. Second, both age groups exhibit considerable cyclicity: the eruption of the Greek financial crisis led to a sharp decline in the growth rates of both young and mature enterprises. Now let's turn to panel (b). Sales growth rates are significantly higher for small than for large firms. Both sales size groups exhibit considerable cyclicity, but small firms contracted more sharply during the Greek Depression.

For a deeper look at the effects of the financial crisis on the growth patterns by age and size, Table B1 reports the reductions in average growth rates of Greek firms due to the crisis by age and size groups. Two interesting remarks can be made here. First, our sample gives almost the same quantitative reduction in gross output (or aggregates sales) as the data in national-level (23%), a fact that implies that our firm-level dataset resembles at a large extent the aggregate economy. Second, the crisis effect was significantly more severe in small (young) firms than in large (mature) firms. In particular, the fall in the firm growth due to crisis was 8 percentage points larger for young than for mature firms and 2.5 percentage points larger for small than for large firms.

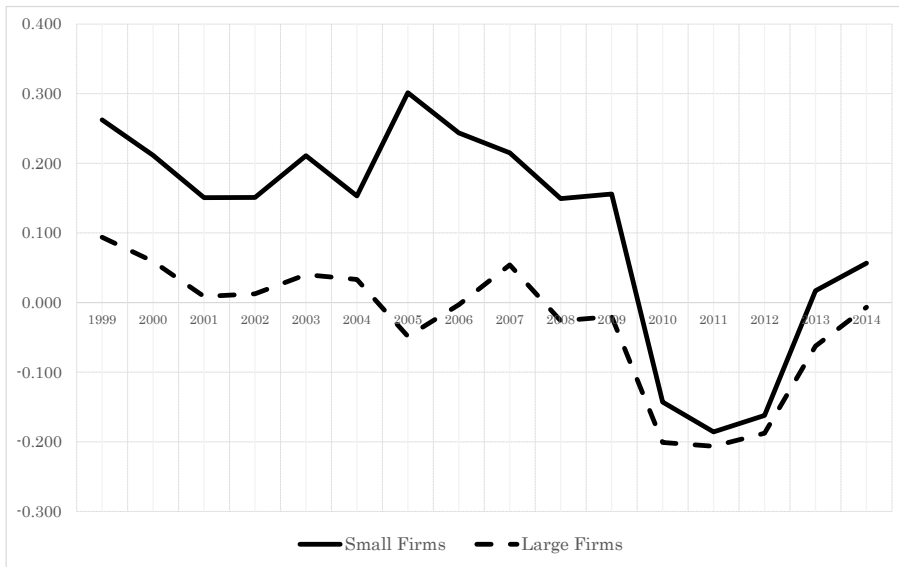
Therefore, the Greek Depression was more destructive for young (relative to mature) and small (relative to large) firms. But, what were the potential drivers of this excess sensitivity of young and small firms to the financial crisis? In Figure B2, we investigate the role of financing constraints in the reductions of firm growth rates due to the crisis by age (panel (a)) and size (panel (b)) groups. In particular, we present the average reductions of the firm growth rates due to the crisis by age and size, separately for financially constrained and unconstrained firms.²³ Several interesting remarks can be made. First, financially constrained firms were hit more by the financial crisis than their counterparts with loosen credit constraints across all age and size groups. However, it is striking that this result is much stronger for young (relative to mature) and for small (relative to large) firms. The implication is that at least part of the story for why sales growth rates for young/small firms fell so much during the crisis must be associated with the financial distress that young/small

²²For the definitions of the age and size groups, see Section 3.2 of the main manuscript.

²³Recall from the previous Section that we consider financially constrained the firms entering the crisis with high financial leverage.



(a) Firm Growth By Age



(b) Firm Growth By Age

Figure B1: Firm Growth Patterns by Age and Size Groups

Notes: In this figure we present the dynamic patterns of firm growth rate by age (panel (a)) and size (panel (b)) groups. Firm growth is defined as the logarithmic difference of deflated sales. Firm size is defined as the logarithm of gross sales in period $t - 1$, deflated by the Producer Price Index (PPI). A firm is defined as “mature” if its age is larger than 5 years and “young” otherwise. A firm is defined as “small” if its size is below the 60th percentile of the size distribution and “large” if its size is larger than the 90th percentile of the size distribution.

firms had to dealt with after the eruption of the crisis.

	Decline in Aggregate Sales (2009-2014)	Fall in Average (Sales) Growth Rate from Boom to Crisis	Growth Differentials
Firm-level Data			
Young	-29%	-35.4 p.p.	<u>Young-Mature</u>
Mature	-21%	-27.4 p.p.	-8 p.p.
Small	-26%	-13.9 p.p.	
Large	-18%	-11.4 p.p.	<u>Small-Large</u>
All Firms	-23%		-2.5 p.p.
Macro Data	-23%	-8.8 p.p.	

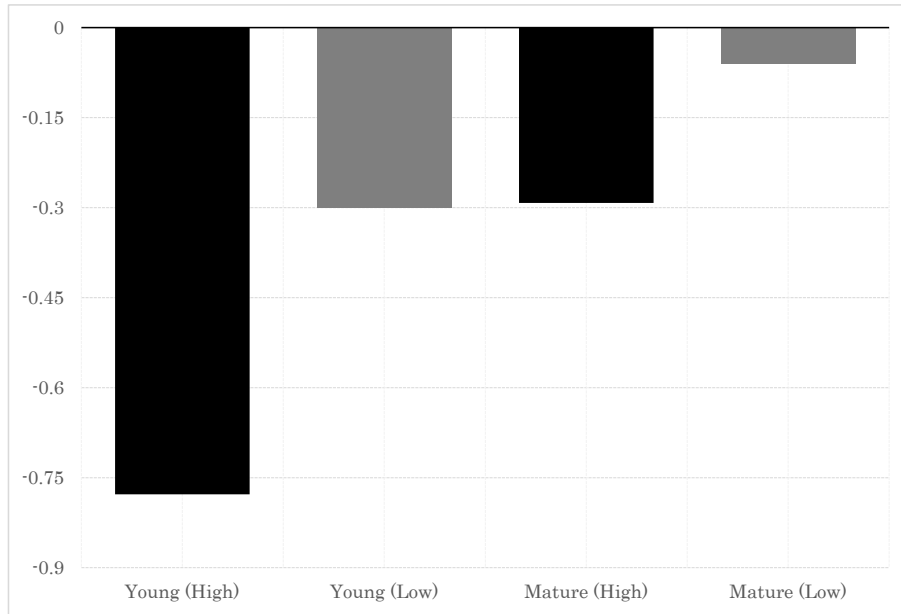
Notes: In this Table we present the quantified impact of the Greek Depression on the aggregate sales and the average growth rates of Greek firms in our sample. The fall in average growth rate from boom to crisis is calculated as $g^{Cr,k} - g^{Bm,k}$, where Bm and Cr stand for the “boom or pre-crisis” (1998-2009) and “crisis” (2010-2014) periods respectively, and $k = \{\text{young, mature, small, large}\}$. With the term “growth differentials” we refer to the following expressions $(g^{yng} - g^{mtr})^{Cr} - (g^{yng} - g^{mtr})^{Bm}$ and $(g^{sml} - g^{lrg})^{Cr} - (g^{sml} - g^{lrg})^{Bm}$ with which we quantify the differential impact of Greek Depression to the growth rates of young relative to mature firms and of small relative to large firms respectively.

Table B1: The Impact of Greek Depression on Firm Growth by Firm Age and Size

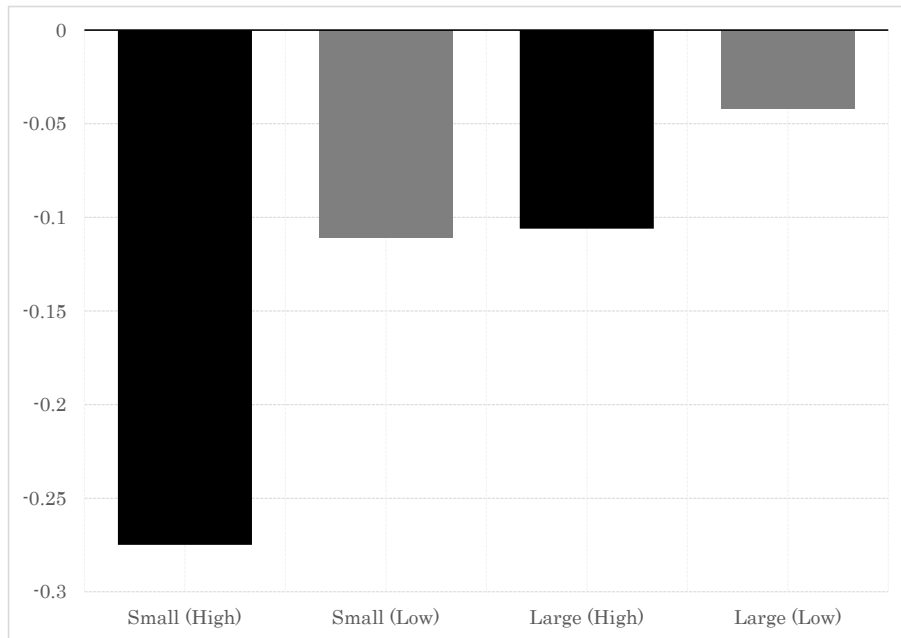
In Figures B3, we investigate the role of unexpected demand shocks in the reductions of firm growth rates due to the crisis by age (panel (a)) and size (panel (b)) groups. In particular, we present the average reductions of the firm growth rates due to the crisis by age and size, separately for firms that experienced or not “lower (less favourable) demand shocks”.²⁴ Two observations emerge here. First, as we expected the financial crisis was more destructive for firms that experienced an “lower (less favourable) demand shocks” episode. Second, although this result was particularly strong for small (relative to large) firms, it was much milder for young (relative to mature) firms.

It is important to discuss entry and exit of firms in our sample. Figure B4, Panel (a), displays the evolution of the number of firms in our sample. The number of firms decreased substantially after the onset of the Greek financial crisis (by 20% from 2010 to 2013). Panel (b) shows that this decline in firm numbers during the crisis was driven by the increased rate of exiting firms.

²⁴See Section 3.2 on how we define less favourable unexpected demand shocks.



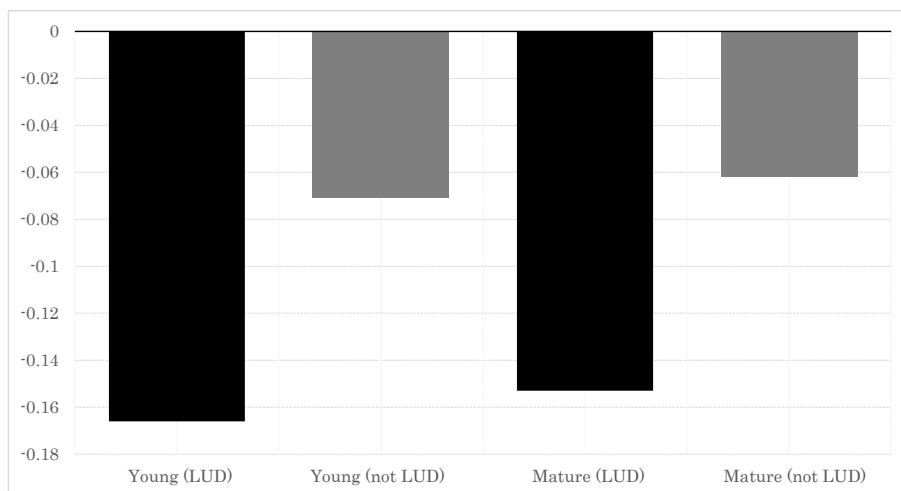
(a) Firm Growth Reductions by Age



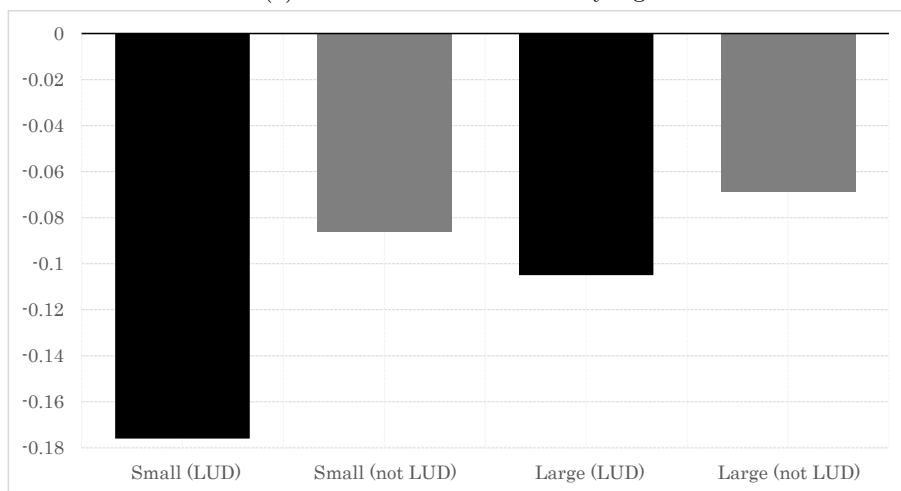
(b) Firm Growth Reductions by Size

Figure B2: Firm Growth Reductions due to the Financial Crisis by Age and Size Groups: The Role of Financing Constraints

Notes: In this figure we present the average reductions of firm growth rates due to the crisis by age (panel (a)) and size (panel (b)) groups, separately for financially constrained and unconstrained firms. For the definitions of firm age and size groups along with the definition for financing constraints see Section 3.2.



(a) Firm Growth Reductions by Age



(b) Firm Growth Reductions by Size

Figure B3: Firm Growth Reductions due to the Financial Crisis by Age and Size Groups: The Role of Unexpected Demand Shocks

Notes: In this figure we present the average reductions of firm growth rates due to the crisis by age (panel (a)) and size (panel (b)) groups, separately for firms that experienced or not lower (less favourable) unexpected demand shocks (see Section 3.2 for the relevant definitions).

Before the financial crisis, the number of entries exceeded the number of exits. This was reversed during the crisis. Panels (c) and (d) present the number of exiting firms in the data by age and size groups. As we can see, the incidence of entry and exit varies substantially by age and size. The majority of exiting firms were small or young. It seems that firm age or size was a good indicator for firm survival during the Greek Depression.

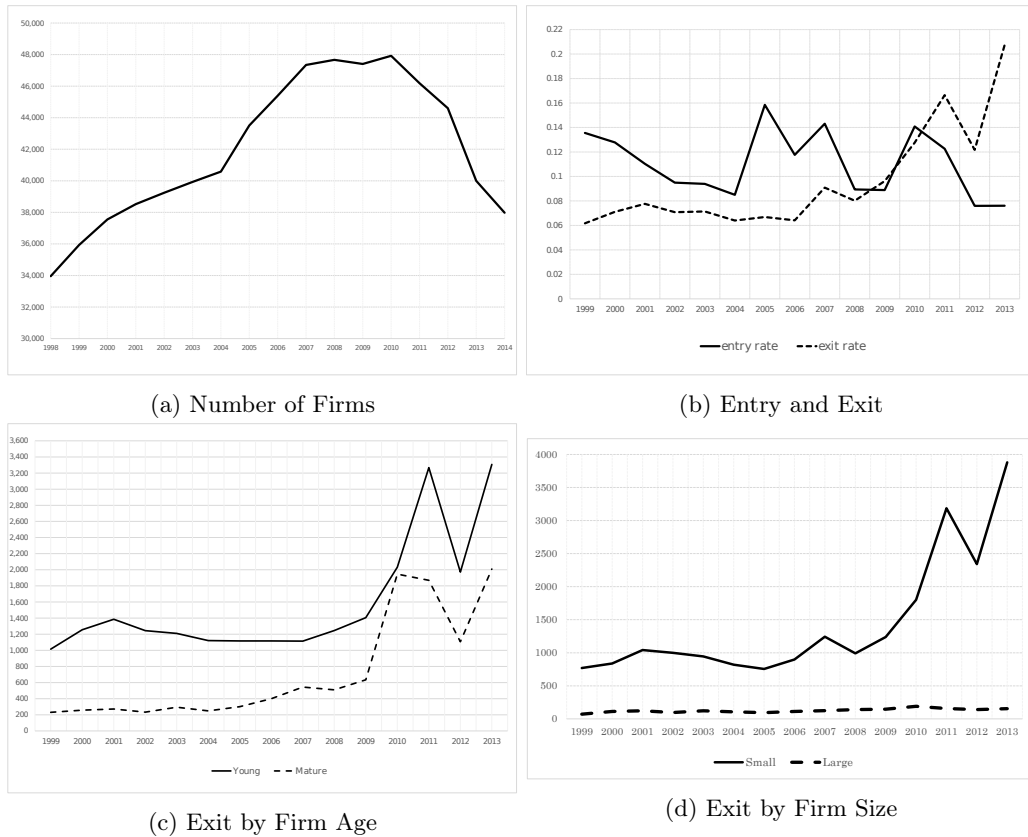


Figure B4: Entry, Exit and the Number of Firms

Notes: In this figure we present the dynamic patterns of the number of firms, the firm entry, and the firm exit in our sample. Panel (a) depicts the evolution of the number of firms in our dataset, whilst Panel (b) illustrates the patterns of firm entry and exit rates in our sample. Panel (c) presents the number of firm exits in our dataset for young and mature firms. A firm is defined as “mature” if its age is greater than 5 years and “young” otherwise. Panel (d) depicts the number of firm exits for small and large firms (we omit the medium-sized firms). Firms are classified into three sales size groups: small for percentiles 1-50 of the sales distribution, medium for percentiles 51-90 and large for the percentiles 91-100.

We would like to stress that, since our dataset is not a census of the Greek economy, the entry and exit rates displayed in this Figure do not correspond only to economic decisions to start a business or close it. They also include a portion that reflects selection into the sample. Both

economic survival and sample selection introduce potential bias in inferences based on Figure 9. The econometric methodology we follow in this study enables us to correct for selection bias due to both business starts and failures and the sampling procedure. This methodology will be presented in the following section. The importance of endogenous entry-exit decisions (that create a selection bias) for firm dynamics has been pointed out in the literature from very early (e.g. [Mansfield, 1962](#); [Hall, 1987](#); and [Marsili, 2001](#)).

From the above analysis, it seems that the Greek Depression was particularly destructive for young and small firms. Financing constraints and unexpected demand shocks may have played an important role in this excess sensitivity of young and small firms to the financial crisis, although the role of the latter driver is more profound for small firms than for young. In addition, the entry-exit channel seems to be an important factor for the analysis of the growth trajectories by age and size over the cycle.

C Function Form $g(\cdot)$ from Econometric Specification 4.2

One component of the econometric specification 4.2 is the functional form $g(\cdot)$. $g(\cdot)$ is a linear function of the seven variables $young_{i,t}$, $small_{i,t}$, $large_{i,t}$, $FC_{i,t}$, $LUD_{i,t}$, and $crisis_t$ together with complete interactions between them. The exact form of function $g(\cdot)$ is:

$$\begin{aligned}
 &g(young_{i,t}, small_{i,t}, large_{i,t}, FC_{i,t}, LUD_{i,t}, crisis_t; \alpha) \\
 &= \beta_1 young_{i,t} + \beta_2 small_{i,t} + \beta_3 large_{i,t} + \beta_4 (young \times small)_{i,t} + \beta_5 (young \times large)_{i,t} \\
 &\quad + \beta_6 crisis_{i,t} + \beta_7 (young \times crisis)_{i,t} + \beta_8 (small \times crisis)_{i,t} + \beta_9 (large \times crisis)_{i,t} \\
 &\quad + \beta_{10} (young \times small \times crisis)_{i,t} + \beta_{11} (young \times large \times crisis)_{i,t} \\
 &\quad + \alpha_{12} FC_{i,t} + \beta_{13} (young \times FC)_{i,t} + \beta_{14} (small \times FC)_{i,t} + \beta_{15} (large \times FC)_{i,t} \\
 &\quad + \beta_{16} (young \times small \times FC)_{i,t} + \beta_{17} (young \times large \times FC)_{i,t} + \beta_{18} (FC \times crisis)_{i,t} \\
 &\quad + \beta_{19} (young \times FC \times crisis)_{i,t} + \beta_{20} (small \times FC \times crisis)_{i,t} + \beta_{21} (large \times FC \times crisis)_{i,t} \\
 &\quad + \beta_{22} (young \times small \times FC \times crisis)_{i,t} + \beta_{23} (young \times large \times FC \times crisis)_{i,t} \\
 &\quad + \alpha_{24} LUD_{i,t} + \beta_{25} (young \times LUD)_{i,t} + \beta_{26} (small \times LUD)_{i,t} + \beta_{27} (large \times LUD)_{i,t} \\
 &\quad + \beta_{28} (young \times small \times LUD)_{i,t} + \beta_{29} (young \times large \times LUD)_{i,t} + \beta_{30} (LUD \times crisis)_{i,t} \\
 &\quad + \beta_{31} (young \times LUD \times crisis)_{i,t} + \beta_{32} (small \times LUD \times crisis)_{i,t} + \beta_{33} (large \times LUD \times crisis)_{i,t} \\
 &\quad + \beta_{34} (young \times small \times LUD \times crisis)_{i,t} + \beta_{35} (young \times large \times LUD \times crisis)_{i,t} + \alpha_{36} FC \\
 &\quad \times LUD_{i,t} + \beta_{37} (young \times FC \times LUD)_{i,t} + \beta_{38} (small \times FC \times LUD)_{i,t} + \beta_{39} (large \times FC \times LUD)_{i,t} \\
 &\quad + \beta_{40} (young \times small \times FC \times LUD)_{i,t} + \beta_{41} (young \times large \times FC \times LUD)_{i,t} \\
 &\quad + \beta_{42} (FC \times LUD \times crisis)_{i,t} + \beta_{43} (young \times FC \times LUD \times crisis)_{i,t} \\
 &\quad + \beta_{44} (small \times FC \times LUD \times crisis)_{i,t} + \beta_{45} (large \times FC \times LUD \times crisis)_{i,t} \\
 &\quad + \beta_{46} (young \times small \times FC \times LUD \times crisis)_{i,t} + \beta_{47} (young \times large \times FC \times LUD \times crisis)_{i,t}
 \end{aligned}$$



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